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Под научной редакцией *И. Ю. Окунева*


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ATLAS OF HUMAN DEVELOPMENT

MULTIDIMENSIONAL SCALING,
CLUSTERING,
SPATIAL DATA ANALYSIS

Edited by *Igor Okunev*
Translated by *Philip Taylor*



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This atlas presents a comparative analysis of the distribution of human potential worldwide against amidst increasing differentiation among countries and regions. It includes cartograms reflecting information on 105 indicators across various areas such as geography, demography, economics, finance, politics, equality, education and science, health, culture, mobility and environment. The underlying research allows to identify key trends in the distribution of human potential among countries, as well as the significance of the «neighborhood effect» in spatial differentiation of human development. For this purpose, methods of spatial econometrics and geo-information modelling are employed, using the QGIS and GeoDA geoprocessing packages and the R programming language. The book provides a systematic view of the uneven socio-economic and political development and reveals both the specifics of countries and regions of the world and common patterns among them.

For a wide range of specialists in social geography, social sciences, and humanities, as well as experts, analysts, and researchers interested in spatial patterns of human development.

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Table of Contents

PREFACE	9
1. RESEARCH METHODOLOGY	11
2. DEMOGRAPHICS	31
2.1. Population density	34
2.2. Urbanization	38
2.3. Population growth	42
2.4. Infant mortality	46
2.5. Life expectancy	50
2.6. Young population	54
2.7. Elderly population	58
2.8. Female population	62
2.9. Marriage	66
2.10. Refugees	70
2.11. Multifactor analysis of the “Demographics” section indicators	74
2.12. Spatial factor for the “Demographics” section indicators	79
3. ECONOMY	83
3.1. GDP (PPP) per capita	86
3.2. Agriculture	90
3.3. Industry	94
3.4. Medium- and hi-tech industries	98
3.5. Rate of gross accumulation	102
3.6. Services sector	106
3.7. Imports	110
3.8. Exports	114
3.9. Unused export potential	118
3.10. Regional trade agreements	122
3.11. Multifactor analysis of the “Economy” section indicators	126
3.12. Spatial factor and “Economy” section indicators	131
4. FINANCES	135
4.1. Tax revenues	137
4.2. Budget deficit	141
4.3. Sovereign debt	145
4.4. Bank deposits	149
4.5. Short-term consumer loans	153
4.6. Loans to domestic companies	157
4.7. Foreign assets	161
4.8. Inward FDI debt stocks	165
4.9. FDI inflows	169
4.10. Royalties to foreign copyright holders	173
4.11. Multifactor analysis of the “Finance” section indicators	177
4.12. Spatial factor and “Finance” section indicators	182
5. POLITICS	185
5.1. Institutional foundations of democracy	188
5.2. Voter turnout	192
5.3. Women in politics	196

5.4. Public organizations	200
5.5. Corruption	204
5.6. IMF voting power	208
5.7. Diplomatic missions	212
5.8. Passport power	216
5.9. Conflictogenity	220
5.10. Military spending	225
5.11. Multifactor analysis of the “Politics” section indicators	229
5.12. Spatial factor and “Politics” section indicators	234
6. EQUALITY	240
6.1. Poverty level	242
6.2. Economic inequality	246
6.3. Highly wealthy population	250
6.4. Unemployment	254
6.5. Female unemployment	258
6.6. Female labour	262
6.7. Maternal mortality	266
6.8. Gender parity at school	270
6.9. Hospital beds	274
6.10. Access to electricity	278
6.11. Multifactor analysis of the “Equality” section indicators	282
6.12. Spatial factor and “Equality” section indicators	287
7. EDUCATION AND SCIENCE	291
7.1. Primary education enrolment	294
7.2. Secondary education enrolment	298
7.3. Tertiary education enrolment	302
7.4. Quality of school education	306
7.5. Years at school	310
7.6. Primary school dropouts	314
7.7. Education spending	318
7.8. Number of researchers	322
7.9. R&D spending	326
7.10. Publication activity	330
7.11. Multifactor analysis of the “Education and Science” section indicators	334
7.12. Spatial factor and the “Education and Science” section indicators	339
8. HEALTHCARE	343
8.1. Healthcare spending	345
8.2. Number of doctors	349
8.3. Pharmaceutical exports	353
8.4. Hepatitis B vaccinations	357
8.5. Antiretroviral therapy (ART)	361
8.6. HIV incidence	365
8.7. COVID-19 mortality	369
8.8. Tuberculosis morbidity	373
8.9. Alcohol consumption	377
8.10. Suicide rate	381
8.11. Multifactor analysis of “Healthcare” section indicators	385
8.12. Spatial factor and “Healthcare” section indicators	390

9. CULTURE	393
9.1. Cultural solidarity	396
9.2. Ethnic fractionalization	400
9.3. Ethnic minorities	404
9.4. Linguistic diversity	408
9.5. Religious diversity	412
9.6. Cultural exports	416
9.7. Bioethical freedom	420
9.8. Film industry	424
9.9. Literacy	428
9.10. Number of libraries	432
9.11. Multifactor analysis of the “Culture” section indicators	436
9.12. Spatial factor for the “Culture” section indicators	441
10. MOBILITY	445
10.1. Capitalness	448
10.2. Money transfers	452
10.3. Inbound tourism	456
10.4. Mobile subscribers	460
10.5. Internet users	464
10.6. Railway network	468
10.7. Motorways	472
10.8. Petrol prices	476
10.9. Load on freight ports	480
10.10. Air passengers	484
10.11. Multifactor analysis of the “Mobility” section indicators	488
10.12. Spatial factor for the “Mobility” section indicators	493
11. ECOLOGY	495
11.1. Agricultural land	499
11.2. Forest areas	503
11.3. Conservation areas	507
11.4. Depletion of natural resources	511
11.5. Fresh water	515
11.6. Renewable energy	519
11.7. Availability of electricity	523
11.8. CO ₂ emissions	527
11.9. Particulate air pollution	531
11.10. Light pollution	535
11.11. Multifactor analysis of the “Ecology” section indicators	539
11.12. Spatial factor for the “Ecology” section indicators	545
12. SPATIAL CLUSTER ANALYSIS	549
13. MULTIDIMENSIONAL SCALING	569
RESEARCH TEAM	588

Preface

The era of global turbulence has given rise to a particularly strong demand for consistent patterns of global development that could serve as a point of reference during a period of profound transformations. The rapid improvement of information technologies makes it possible to partially satisfy this demand through the widespread use of quantitative methods, even in those areas that were previously amenable to expert assessments only. There is no denying that econometric techniques are still not able to fully convey the complexity of social and political processes. However, every step in this direction opens up new opportunities for a more detailed analysis and a more nuanced understanding of social dynamics.

The *Atlas of Human Development* has been prepared by an inter-university team of authors under the auspices of the Center for Spatial Analysis in International Relations of the Institute for International Studies at MGIMO University. The project is part of the “Global Spatial Aspects of Human Potential” programme implemented by the world-class Human Capital Multidisciplinary Research Center under Grant Agreement No. 075-15-2022-327 with the Ministry of Science and Higher Education of the Russian Federation (2022–2024). The Atlas represents the findings of several years of study into the spatial structure of society in its most diverse manifestations, from demography and economics to culture and mobility. Factors in the development of human potential are distributed unevenly across the globe, and the features of this distribution must be taken into account, not only when studying different countries, but also when developing state policies. This assumption served as the starting point for this study.

The goal of the project is to employ spatial statistical analysis and geographic information systems to model the spatial structure of the areas under study and identify country clusters in which the “neighbourhood effect” – the correlation of an indicator value with that demonstrated in surrounding countries – is most pronounced. To avoid the false interpretation of the quantitative data obtained, the authors turned to subject-matter experts.

This book is a logical continuation of the previous study, *Atlas of International Relations: Spatial Analysis of World Development Indicators*, published in 2020. However, the team made significant progress in the intervening period – both quantitatively, increasing the number of indicators analysed, and qualitatively, expanding the range of the spatial econometrics methods used and deepening the analysis of the results obtained.

One of the most significant innovations of this publication is the use of two neighbourhood matrices: the geometric neighbourhood matrix, which reflects the simple adjacency of countries; and the geopolitical neighbourhood matrix, which models the structure of world politics based on integration systems. The comparative analysis of the spatial distribution of one hundred human potential indicators in most UN member countries shows that the geopolitical structure of the world is still less significant for global development than the geometric structure, which means that states should continue to place special emphasis on maintaining stability in their regions and create conditions for mutually beneficial cooperation with their neighbours in the interests of development.

From a methodological point of view, the experience of creating a geopolitical neighbourhood matrix opens up new opportunities for modelling other systemic matrices that reflect the structure of relative, rather than absolute, space. For example, depending on the purposes of the study, such matrix could be based on a linguistic principle, or an affiliation with certain empires in the past.

Aggregating all the data in the study drawing on spatial cluster analysis and multidimensional scaling produces similarly interesting results. The division of the world into two clusters clearly demonstrates the divide between the Global North and the Global South, which remains a fundamental cleavage dimension of modern global dynamics. Multidimensional scaling makes it possible to analyse the modern world order in terms of the similarities and differences between states. Two countries in particular stand out in this regard, in terms of the degree of their dissimilarity from other countries – namely, the United States and China. It is noteworthy that the same quadrant of the multidimensional scaling diagram is occupied not only by the leading Western countries, but also by the founders of BRICS – Russia, Brazil, and India – albeit at a considerable distance from the United States and China. This quantitative assessment thus reflects the pivotal role of these states in determining the parameters of the emerging world order.

The study conducted here is of a great scale. However, the potential of the methodology used is even more far reaching and promising, especially on a sub-national level and in cross-temporal comparison. We can only hope that, in the future, spatial analysis will allow not only to conduct more detailed research, but also to lay a strong foundation for efficient state policies in a variety of areas.

Dr Andrey Baykov
Vice-Rector for Research Affairs, MGIMO University,
Chair, Governing Council NCMU-MGIMO,
«Human Capital Multidisciplinary Research Center»

1

Research Methodology

RESearch problem. Various academic projects frequently leave the spatial distribution of social phenomena underinvestigated. This study is an attempt to fill this gap.

The global distribution of human capital is uneven, with both distribution extremes — super-concentration in certain regions and equal distribution throughout the planet — being equally pernicious. Hence the research objective posited in our study: researchers need to analyse trends and factors that operate in the spatial distribution of human potential indicators in order to better design state policies and the global agenda in terms of developing regional systems of school and higher education, healthcare, and environmental protection, as well as combating unemployment, planning retirement payments, etc. In addition, countries need to establish strategies for the optimal distribution of their human potential throughout their territories, which would allow them, on the one hand, to improve their global competitive edge through super-concentration in individual clusters and, on the other hand, to ensure equal spatial development of each and every one of their regions.

This study will focus on testing the spatial statistic (econometric) analysis methodology of identifying the impact geographic factor has on the global human potential distribution.¹ Waldo R. Tobler's first law of geography, "everything is related to everything else, but near things are more related than distant things," means that the distribution of any phenomenon in the world, including human potential, is determined by the geographic factor (in other words, by the "neighbourhood effect"). At the same time, we know that social institutions, primarily the state, are capable of overcoming spatial patterns and changing the nature of regional spatial distribution through, for instance, state borders. Therefore, geography and society/politics turn out to be antagonists in the matter of distributing human development resources: geography strives to subordinate the distribution of human capital to spatial laws, while society and state strive to subordinate it to national interests.

The goal of our study, therefore, lies in using quantitative methods of spatial econometrics and geoinformational modelling in order to, first, determine current trends in the regional distribution of human potential throughout the world, and, second, to identify the role the geographic factor plays in this differentiation, or, in

¹ Study Carried Out under Grant Agreement No. 075-15-2020-930 in 2020-22 and No. 075-15-2022-327 in 2022-24 funded by the Ministry of Science and Higher Education of the Russian Federation.

other words, to identify those areas of human development where the spatial “neighbourhood effect” proves significant.

The project was carried out by a team of research fellows and research interns at the Center for Spatial Studies in International Relations at MGIMO’s Institute for International Studies with the participation of scientists from Moscow State University, the Higher School of Economics National Research University, the Peoples’ Friendship University of Russia, Perm State National Research University, and the Institute of Europe of the Russian Academy of Sciences, collaborating under the auspices of the Center for Interdisciplinary Research into Human Potential. The project was designed by Dr. Igor Okunev (MGIMO University), who also led the research team. The complete research team is listed in an addendum to the Atlas, where the authors of each section are indicated.

The project used the ArcGIS Pro, QGIS and GeoDa geoinformation systems, and the R and Python programming languages.

The research team had partially tested the study’s methodology while preparing the first geostatistic international relations Atlas in Russian.

Cartographic base. In order to visualize the spatial analysis data, the team designed its own cartographic base that reproduces generally recognized state borders of the 193 full-fledged UN members (i.e. those that are not observer states), since reliable statistics can be found for those countries. The research team used the cartographic base created by Poland’s EnviroSolutions GIS-lab as its basis, with coordinates for the state borders of all the countries and territories of the world as of March 2019.¹ Dependent and international territories were removed from the cartographic base since, without statistic data, they would distort the calculations of neighbourhood indicators. There are, however, two exceptions: the two largest continental dependent territories, Western Sahara and French Guiana, since excluding them from consideration would have seriously distorted continental outlines. They were treated as part of Morocco and France, respectively.

For visualizing the parameters in the Atlas, the research team selected the Eckert IV projection, an equal-area pseudocylindrical map projection (developed by Max Eckert in 1906).² Meridians in this projection are equally distributed semiellipses that meet at the central meridian. Semicircles of the lateral meridians form the rounded borders of the grid. The central meridian is a straight line and equals half the length of the projected equator. Lines that correspond to the poles are of the same length. Parallels are unequally distributed straight lines perpendicular to the central meridian. The angles at which lateral meridians cross pole lines are smoothed out. The projection has a grade frame symmetrical about the equator and the central meridian.

Both visually and essentially, the Eckert IV projection is greatly different from the equiangular cylindrical Mercator projection that is more widely used in today’s cartography. The Mercator projection was originally designed for the purposes of maritime navigation because every straight line thereon reflects an exact azimuth. However, area distortions in this projection increase significantly closer to the poles. That is, the sizes of countries close to the equator appear disproportionately small compared to states further removed from the equator.³ Such distortions visually increase the significance of countries proximate to poles, that is, primarily of the countries of the so-called developed North. Since the purpose of this Atlas is to adequately represent various characteristics of countries in order to assess human development potential, we preferred to use the projection that does not artificially favour states proximate to the poles. Due

¹ Otwarte Dane GIS. Enviro Solutions. URL: <https://www.envirosolutions.pl/otwarte-dane.html> (accessed: 26.09.2021).

² Eckert IV. ArcGIS Pro information. URL: <https://pro.arcgis.com/en/pro-app/latest/help/mapping/properties/eckert-iv.htm> (accessed: 11.11.2021).

³ Mercator. ArcGIS Pro information. URL: <https://pro.arcgis.com/en/pro-app/2.7/help/mapping/properties/mercator.htm> (accessed: 11.11.2021).

to its exact representation of areas, the Eckert IV Projection made the list of the most widely used by the United Nations.¹

The cartographic base is available on the website of the Center for Spatial Analysis in International Relations at the MGIMO IIS in the Research Project section.²

Indicator selection. The research team selected 100 indicators for research. Together, these indicators create a stereoscopic picture of all human development aspects: demographics, economy, finance, politics, equality, education and science, healthcare, culture, mobility, and environment. The team selected ten indicators for each of these areas, thereby balancing out these human development areas in the subsequent multidimensional spatial analysis. The selection is based on the UN Human Development Index.³ The goal was not to select indicators that in their totality provide an assessment of the level of human potential of countries or to create a ranking of states by this indicator. Our task lay exclusively in selecting those indicators that most fully reflect the various aspects of human potential, thereby allowing the team to measure the impact geographic factor has on regional differentiations in the entire range of development aspects throughout the world.

In selecting the indicators, the research team used the following criteria:

- multicollinearity: the indicator should not be a complex index based on a group of other indicators;
- heteroskedasticity: the indicator is not indirectly connected to the size of a given state; preference, therefore, is given to relative indicators measuring a quantitative ratio to the given state's size, population, or GDP;
- dispersion: the indicator measures data spread where the difference between maximum and minimum values in an ordered sample is below 1000 times (or would be measured per mille) to allow for plotting anamorphic maps;
- sampling: the indicator is available for no less than 80% of UN member states (i.e. for a minimum of 154 states out of 193) to make an assessment of the level of its worldwide spatial autocorrelation possible;
- comparability: the indicator has a comparable analogue among indicators collected for Russian regions, and is collected for no less than 80% of Russian regions (i.e. for a minimum of 68 regions out of 85) in order to subsequently compare global data to data for Russian regions;
- relevance: the indicator is relevant, i.e. reflects the situation for 2015 at the earliest;
- objectivity: the indicator is not based on expert evaluations.

To be selected, each indicator should meet at least five of the seven criteria above. On the final list, 16% of indicators meet all seven criteria, six meet 70%, and 100% meet five criteria. The list of selected indicators was subsequently fine-tuned using an expert questionnaire and a later cycle of methodological research team workshops. Each section of the Atlas opens with an explanation of the criterion considered therein. All data was collected from free open sources listed in an addendum. In order to standardize subsequent multidimensional analysis, indicator values were used for 2018 or the closest year when data for the indicator was collected. To normalize individual indicators, the research team used data on area, population, and nominal GDP of countries and Russian regions (these indicators were entered into the database as normalizing indicators).

The indicators representing dependent variables were supplemented by five independent geographical variables used to identify the degree of influence that spatial aspects have on human development.

¹ Frequently Asked Questions. Geospatial, Location Information for a Better World. United Nations. URL: <https://www.un.org/geospatial/about/faqs> (accessed: 11.11.2021).

² Cartographic Base by country. Center for Spatial Analysis in International Relations at the MGIMO IIS. Research projects (in Russian). URL: <https://mgimo.ru/upload/2020/12/Strany2020.zip> (accessed: 26.09.2021).

³ UNDP. 2018 Statistical Update: Human Development Indices and Indicators. New York. URL: <http://hdr.undp.org/en/content/human-development-indices-indicators-2018-statistical-update> (accessed: 26.09.2021).

The resulting database was cross-checked and superimposed on the vector level of the cartographic base following ISO 3166-1 Numeric-3.¹

Neighbourhood spatial weights matrices. Spatial analysis is based on the premise that the phenomenon in one cell is affected by the attributes of neighbouring cells. Therefore, before calculating spatial correlation indices, we need to define the “neighbourhood” concept or, in other words, the spatial weights matrix.

Generally, a spatial weights matrix looks like this:

$$W = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1n} \\ w_{21} & w_{22} & \cdots & w_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ w_{n1} & w_{n2} & \cdots & w_{nn} \end{bmatrix}.$$

If i and j are neighbours, spatial weights will be greater than zero. And, vice versa, it is impossible to neighbour oneself, and thus $w_{ii} = 0$. Since we proceed from the premise that the sum of each series in a spatial weights matrix must equal one, the general normalized formula of calculating one cell's neighbourhood will look like this:

$$w_{ij}(s) = w_{ij} / \sum_j w_{ij}.$$

The sum of the entire spatial weights matrix will equal the number of observations:

$$S_0 = \sum_i \sum_j w_{ij}.$$

The original supposition was that the optimal way of determining a state's neighbours is adjacency, i.e. neighbourhood based on topological relations between entities. Entities were deemed adjacent if their borders have points in common (so-called “queen contingency” neighbourhood). Under the “queen contingency” rule, countries are deemed neighbours if they have at least one common border point, i.e. if their sides and corners touch. When doing calculations based on the “queen contingency” rule, the research team discovered that the median number of neighbours on today's political map is three (Fig. 1.1), while over 39 states have no overland neighbours at all (they are island and archipelago states). This data does not allow us to assess spatial autocorrelations.

Therefore, the research team decided to design their own neighbourhood matrices for the project. Proceeding from the median number of neighbours for all states, including island states, the team used the k -immediate neighbour method to determine three closest states. Instead of a state's centroid, the research team selected the geographical coordinates of its capital city as the point for calculating the radius. If a country had more than three neighbours, all land and sea neighbours (neighbours within its territorial waters) were added to the number of neighbours (Fig. 1.2).

A special database was collected for determining the legal borders of all the countries.² We took into consideration land and maritime borders within 12 nautical miles. As our sources, we used the Russian-language encyclopaedia *Poloticheskie sistemy sovremennykh gosudarstv* (Political Systems of Today's States),

¹ Author's Certificate No. 2022621830 Russian Federation. Geoinformation Database of Human Development Indicators in UN Member States / I.Yu. Okunev; S.L. Barinov, A.O. Domanov, L.S. Zhirnova, E.A. Zakharova, P.V. Oskolkov, M.I. Tislenko, M.N. Shestakova, L.P. Shmatkova; Copyright Holder: MGIMO, Ministry of Foreign Affairs of Russia. No. 2022621575; Filed on July 4, 2022; Published on July 25, 2022, Bulletin No. 8.

The database linked to the cartographic base is available on the website of the Center for Spatial Analysis in International Relations at MGIMO (in Russian). URL: <https://mgimo.ru/about/structure/ucheb-nauch/imi/geo/docs/geo-research/#3>.

² Legal Borders of States. Center for Spatial Analysis in International Relations at the MGIMO IIS, 2021 (in Russian). URL: <https://mgimo.ru/upload/2021/02/strani-sosedi.zip> (accessed: 26.09.2021).

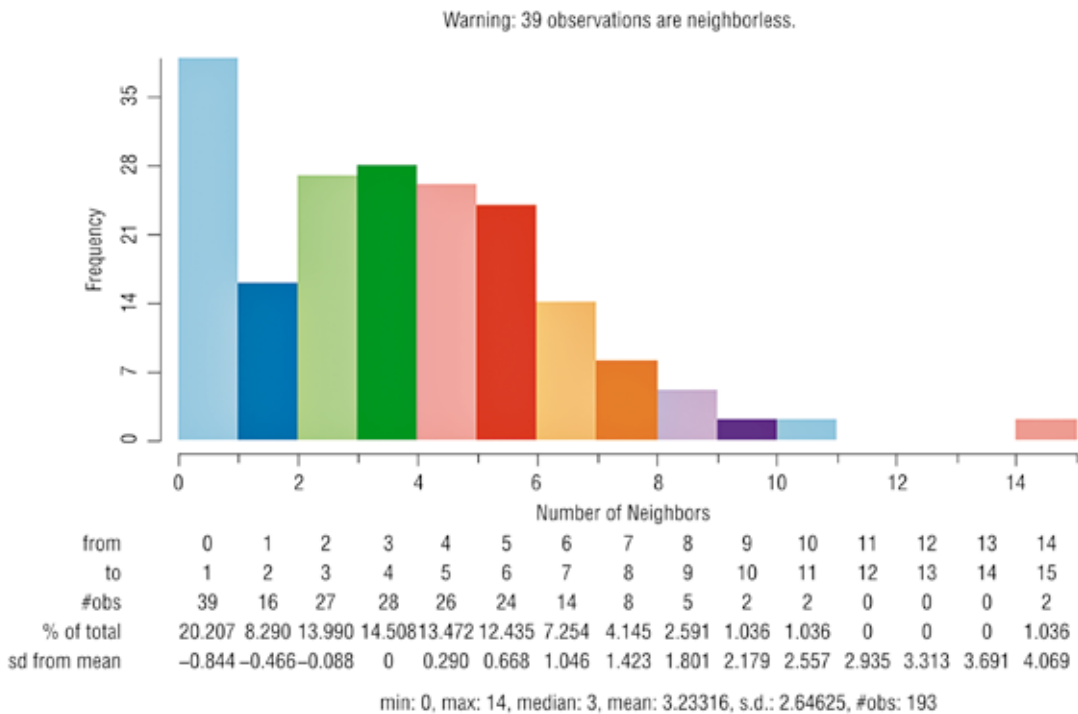


Fig. 1.1. Number of neighbours of UN member states

and the Marine Regions¹ and Sovereign Limits² databases. For the purposes of our study, the following disputed territories are considered to be under the jurisdiction of the following sovereignties: Kashmir (under the sovereignty of India); Kosovo (Serbia); and Western Sahara (Morocco). The border between Cyprus and the United Kingdom was treated as the border between the Republic of Cyprus and British military bases Akrotiri and Dhekelia on the island of Cyprus. The Guantanamo Naval Base is treated as being outside the sovereignty of the United States. The border between Finland and Estonia is drawn at the only point of contact between the territorial seas of the Russian Federation, Finland and Estonia in the Baltic Sea.

Next, the research team used the inverse distance weighting (IDW) method to determine the influence weight for each neighbour of a state in the neighbourhood matrix. For distance, we used the distance between countries' capitals. In other words, the influence weight of a state located closer to the capital of the state under analysis was greater than the weight of a state whose capital was further removed from the capital city of the state under analysis. This operation reduced the effect of isolated territories being included in the analysis.

The described matrix based on the legal borders of countries was used in the Atlas to describe the geometric (or topological) neighbourhood of states that reflects the world's real political map. However, to achieve the objectives of our Atlas, we decided to design an alternative geopolitical matrix that would reflect the current architecture of modern international relations. We decided to imagine the international relations system mathematically and therefore presented it as a matrix of 193x193 UN member states, where each cell corresponds to one of 37,249 bilateral interactions between all the states. Subsequently, we used common memberships in regional political and economic blocs to evaluate each interaction. This approach produced a geopolitical neighbourhood matrix based on similar foreign political behaviour by countries, instead of their physical proximity. In other words, this approach produced a new political map of the world

¹ Marine Regions. URL: https://www.marineregions.org/download_file.php?name=World_24NM_v3_20191118.zip (accessed: 26.09.2021).

² Sovereign Limits. URL: <https://sovereignlimits.com/boundaries> (accessed: 26.09.2021).

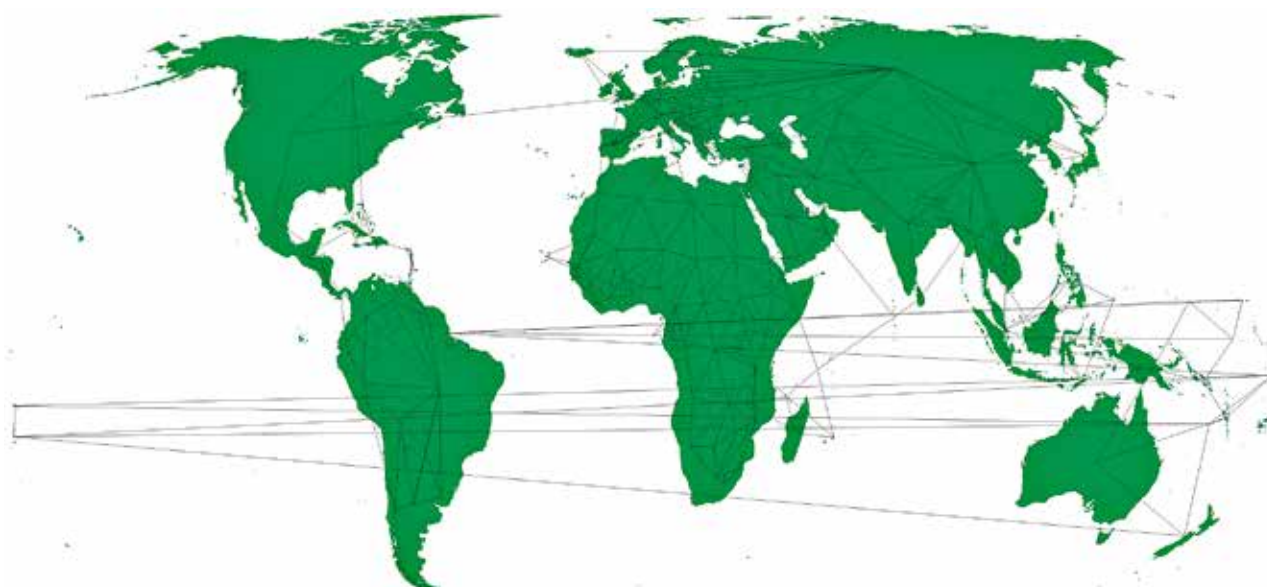


Fig. 1.2. Adjacency graph for a geometric neighbourhood matrix based on the legal borders of countries

as a model of international relations architecture where, for instance, continents are formed by politically — and not physically — proximate states. That allowed us to carry out further spatial econometric analysis in physical and political spaces simultaneously and to draw conclusions on their divergences.

In building a geopolitical neighbourhood matrix, we based the political and geographical proximity of countries on their membership in regional political and economic integration alliances. To analyse each region of the world, we considered those regional blocs that have reached the highest current degree of integration. Involvement, or limited (associated, suspended, planned, etc.), membership in less advanced integration blocs within the same region was counted as 0.5 of the principal membership. The weight of a connection between two states with limited membership in a regional bloc counts as 0.25 of the principal membership. Information about all states is given in Table 1.1 and Figs. 1.3 and 1.4. This approach yields 13 as the median number of neighbours.

Israel, Iran, Mongolia, and North Korea are isolate countries (i.e. they are not members of any regional blocs).

The Russian Federal Service for Intellectual Property (Rospatent) issued an authorship certificate for the geopolitical neighbourhood matrix certifying the state registration of the Structure of Current International Relations: Neighbourhood Spatial Weights Based on Geopolitical Proximity of States Database.¹ Both the geometric² and geopolitical³ matrices are available on the project's website.

Descriptive statistics and likelihood-ratio test. The Atlas first considers each parameter independently in a relevant paragraph. The purpose of this section is to describe a phenomenon's distribution on the po-

¹ Authorship Certificate No. 2021621744 Russian Federation (in Russian). I.Y. Okunev. Copyright holder: MGIMO University under the Ministry of Foreign Affairs of Russia. No. 2021621393; Application No. 08.07.2021; published August 16, 2021, Bulletin No. 8.

² Geometric Matrix of Spatial Neighbourhood Weights (2021) (in Russian). Center for Spatial Studies of International Relations at the IIS of MGIMO University at the Ministry of Foreign Affairs of Russia. URL: https://mgimo.ru/upload/2021/10/Geometry_WM.zip (accessed: 25.11.2021).

³ Geopolitical Matrix of Spatial Neighbourhood Weights (2021) (in Russian). Center for Spatial Studies of International Relations at the IIS of MGIMO University at the Ministry of Foreign Affairs of Russia. URL: https://mgimo.ru/upload/2021/10/Geopolitics_WM.zip (accessed: 25.11.2021).

Table 1.1

Membership of countries' in regional political and economic integration alliances used to calculate a geopolitical matrix of neighbourhood spatial weights

No.	Regional bloc	Full membership (weight of 1.0)	Limited membership (weight of 0.5)
1	CSTO–EAEU–CIS (6+4)	Armenia, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan	Azerbaijan, Moldova, Turkmenistan, Uzbekistan
2	NATO–EU–EFTA–EUCU–SAA/AA (36 + 9)	Austria, Albania, Belgium, Bulgaria, Canada, Czech Republic, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Turkey, UK, US	Andorra, Bosnia and Herzegovina, Georgia, Liechtenstein, Monaco, San Marino, Serbia, Switzerland, Ukraine
3	ASEAN+3 (10 + 4)	Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam	China, East Timor, Japan, South Korea
4	SAARC (8)	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka	
5	GCC–LAS (6 + 14)	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates	Algeria, Djibouti, Egypt, Eritrea, Jordan, Iraq, Lebanon, Libya, Mauritania, Morocco, Somalia, Sudan, Syria, Tunisia, Yemen
6	UEMOA–ECOWAS (8 + 7)	Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, Togo	Cabo Verde, Gambia, Ghana, Guinea, Liberia, Nigeria, Sierra Leone
7	CEMAC–ECCAS (6 + 1)	Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Gabon	São Tomé and Príncipe
8	EAC–IGAD (5 + 2)	Burundi, Kenya, Rwanda, Tanzania, Uganda	Ethiopia, South Sudan
9	SACU–SADC (5 + 10)	Botswana, Eswatini, Lesotho, Namibia, South Africa	Angola, Comoro Islands, Democratic Republic of the Congo, Madagascar, Malawi, Mauritius, Mozambique, Seychelles, Zambia, Zimbabwe
10	MERCOSUR–LAIA (4 + 8)	Argentina, Brazil, Paraguay, Uruguay	Bolivia, Chile, Colombia, Cuba, Ecuador, Mexico, Peru, Venezuela
11	CA-4–CAIS (4 + 4)	El Salvador, Guatemala, Honduras, Nicaragua	Belize, Costa Rica, Dominican Republic, Panama
12	OECS–CARICOM (6 + 7)	Antigua and Barbuda, Dominica, Grenada, Saint Vincent and the Grenadines, Saint Kitts and Nevis, Santa Lucia	Bahamas, Barbados, Haiti, Guyana, Jamaica, Suriname, Trinidad and Tobago
13	ANZUS–CU (2 + 12)	Australia, New Zealand	Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

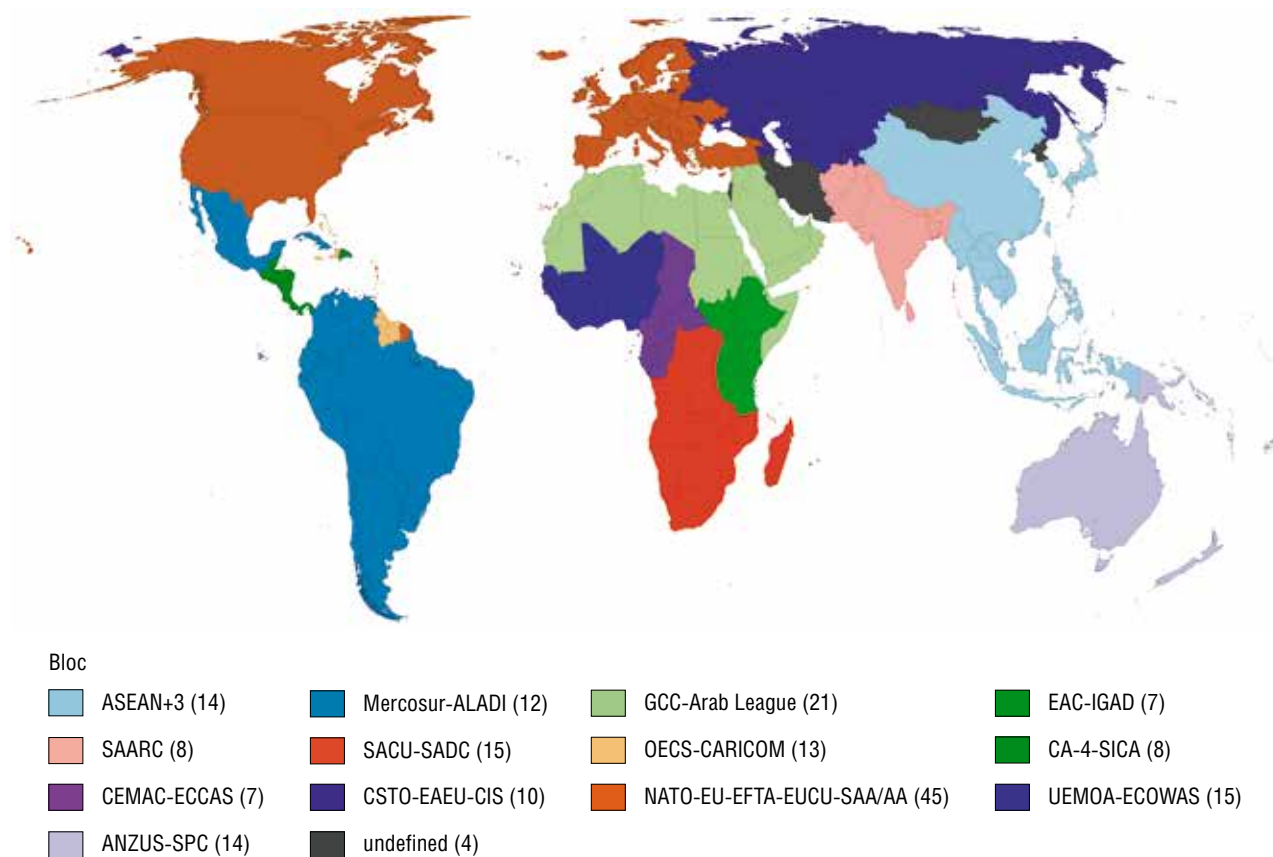


Fig. 1.3. Regional political and economic blocs used for the geopolitical neighbourhood matrix

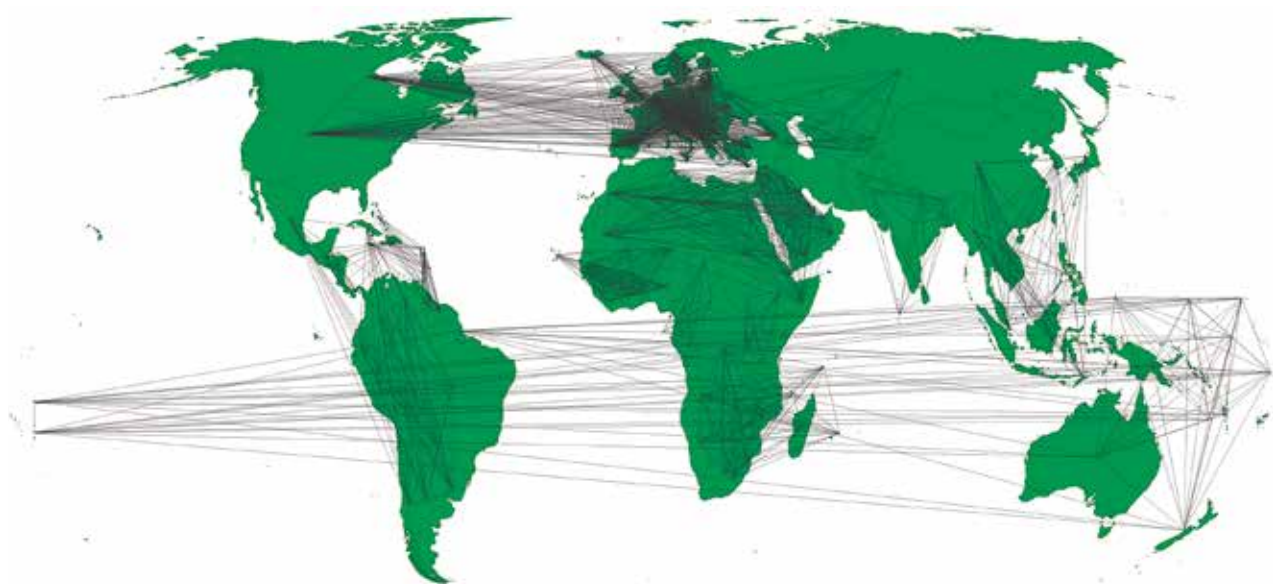


Fig. 1.4. Adjacency graph for the geopolitical neighbourhood matrix based on the membership of countries in political and economic blocs

litical map of the world and to propose assumptions on spatial patterns of this distribution that will subsequently be tested by spatial econometrics methods.

Descriptions of each parameter included the following steps:

- Identifying the average, median, three maximum and three minimum values of the given phenomenon's global distribution.
- Plotting and analysing a percentile cartogram reflecting the phenomenon's global distribution (the percentile cartogram breaks the sampling down into six intervals: 0–1%, 1–10%, 10–50%, 50–90%, 90–99%, 99–100%, with the first and last intervals used for visually representing extreme outliers).
- Likelihood-ratio test calculated for the maximum number of 16 neighbours reflecting which of 16 neighbours of the state under consideration (determined by the proximity of the countries' centroids) are also among the 16 countries with the closest values of the described parameter.

Red lines in the likelihood-ratio test cartogram (Fig. 1.5) show states that are simultaneously geometric neighbours (among the 16 centroids closest to the centroid of the state under consideration). The green gradient in the map key shows which of the states with the most proximate values of the indicator under consideration are also among a given country's 16 most proximate geometric neighbours determined by centroid proximity. The number 16 was selected as the maximum number of official neighbours among all states (Russia's neighbour states).

For certain parameters with a high number of outliers, we chose to use, instead a percentile cartogram, a range cartogram that divides the sampling into six different intervals: top outliers, < 25%, 25–50%, 50–75%, > 75%, bottom outliers.

Spatial autocorrelation. In order to determine spatial correlation for each indicator, we calculated their Moran's I and Geary's. Moran's I is similar to Pearson's correlation coefficient (also varies between –1 and 1), yet it accounts for the neighbourhood effect. Spatial effect is measured as Moran's I by using the spatial lag concept (the average value of a phenomenon in neighbouring cells); in other words, spatial autocorrelation is the ratio of the distribution of a phenomenon in cells to average values in neighbouring cells. The greater

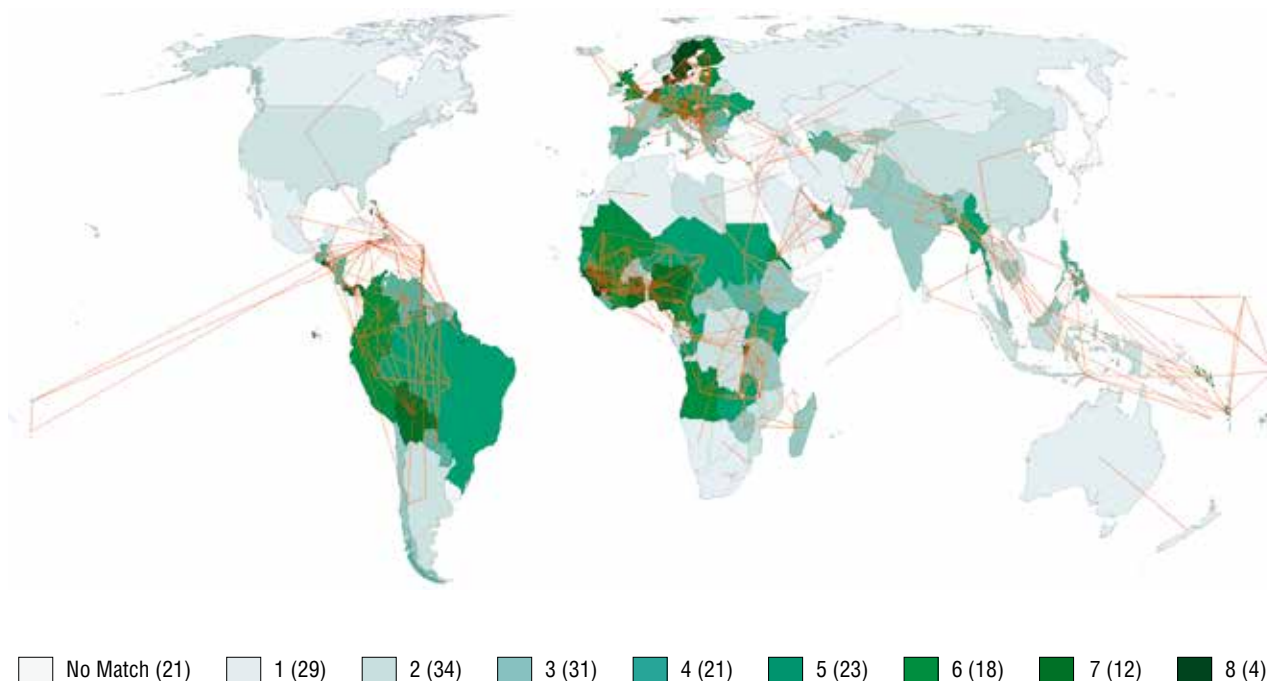


Fig. 1.5. Likelihood-ratio test for the “Elderly population” parameter

the difference between Moran's I and zero is, the greater the phenomenon's spatial clustering will be (either direct or inverse). We used the following formula for our calculations:

$$\text{Moran's } I = \frac{N \sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{W \sum_i (x_i - \bar{x})^2},$$

where i and j are units (countries); and x_i and x_j are values of units i and j (countries); \bar{x} is the sample average for all units; w_{ij} is the spatial relation weights for units i and j ; N is the number of units; and W is the sum of spatial weights.

Fig. 1.6 represents an example of assessing spatial autocorrelation for “Young population” using the geometric matrix of spatial neighbourhood weights. The x-axis shows the normalized young population percentage in each country, the y-axis shows the spatial lag of this indicator, or, in other words, the average share of the young population in countries neighbouring the country under consideration. Moran's I of 0.768 attests to a significant spatial autocorrelation of a phenomenon; in other words, the young population in a given country largely correlates with average young population percentages in neighbouring states.

The sum of Moran's I (in absolute values) for 91 indicators in the Atlas (for all indicators whose p-value for both neighbourhood matrices is less than 0.05, with the exception of independent indicators from the “Geography” section) was 32.204 for the geometric spatial neighbourhood weights matrix and 22.284 for the geopolitical spatial neighbourhood weights matrix. This proves that the neighbourhood effect is 1.44 more significant in absolute space where neighbourhood is determined by legal borders of states and by the territorial proximity of their capitals, than in the relative geopolitical space where neighbourhood is determined by the degree of states' involvement in regional political and economic integration alliances. Table 1.2 lists the Atlas's indicators with the greatest Moran's I for both neighbourhood matrices.

To double-check Moran's I, we used a similar Geary's C that varies between 0 and 2, with a value less than 1 indicating a positive (direct) spatial autocorrelation and value greater than 1 indicating a negative (inverse) autocorrelation. We used the following formula to assess Geary's C:

$$\text{Geary's } C = \frac{N-1 \sum_i \sum_j w_{ij} (x_i - x_j)^2}{2W \sum_i (x_i - \bar{x})^2}.$$

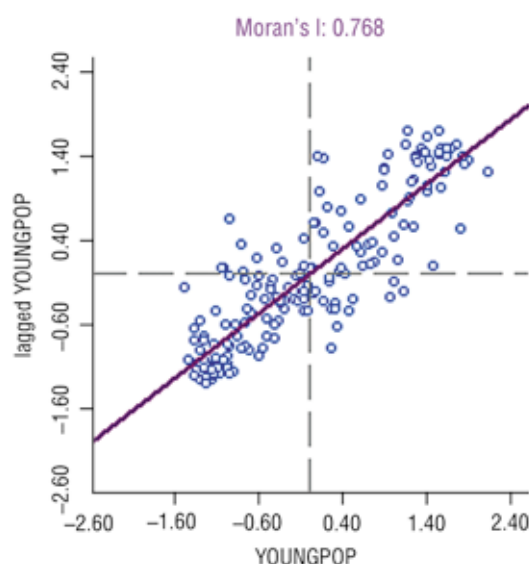


Fig. 1.6. Moran's scatter plot for “Young population”

Moran's I and Geary's C were calculated separately for the geometric and geopolitical spatial neighbourhood weights matrices, while the calculation algorithm used in the R Studio development environment involved replacing empty values with zero values. Every calculation was controlled for p-values; calculations with p-values greater than 0.05 were considered invalid.

Local Indicators of Spatial Association (LISA). Moran's I assesses spatial autocorrelation for the totality of data; however, our research objectives required weighing the spatial autocorrelation between neighbouring entities within individual clusters (global subregions). With that objective in view, we calculated Local Indicators of Spatial Association (LISA). This method identified four types of spatial clusters (Fig. 1.7, the colour black highlights isolate states, or states we did not have statistics for):

- high-high — a spatial autocorrelation cluster with high indicator values for a given phenomenon (red);
- low-low — a spatial autocorrelation cluster with low indicator values for a given phenomenon (indigo),
- high-low — cells with high indicator values for a given phenomenon surrounded by a spatial autocorrelation cluster with low values for a given phenomenon (pink),
- low-high — cells with low indicator values for a given phenomenon surrounded by a spatial autocorrelation cluster with high values for a given phenomenon (light blue).

The following formula was used for the calculations:

$$\text{Local Moran's } I_i = \frac{n}{\sum_{i=1}^n \sum_{j=1}^n w_{ij}} \cdot \frac{\sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n (x_i - \bar{x})^2},$$

where N is the number of cells, z_i is the indicator calculated for cell i , and w_{ij} is the assessment of spatial weights reflecting whether i and j are neighbours: if they are not, it equals 0, and if they are, it equals $1 / |d_{ij}|$, where $|d_{ij}|$ is number of neighbours of cell i .

To prevent outliers from significantly affecting the space lag values in individual local clusters, the project used the median space lag value. Local indicator values for spatial autocorrelation were only mapped for the geometric and geopolitical spatial neighbourhood weights matrices for countries with a p-value less than 0.05. When resulting cartograms failed to visually represent clusters under given parameters, the median space lag value was replaced with average space lag value or omitted values were replaced with zero values (zero values clusters were considered invalid).

Spatial effect index. For each of the 110 indicators selected, we calculated its Pearson correlation coefficient and its Moran's I for 100 other indicators in the Atlas (with the exception of those used as independent geographic variables). If the p-values for the Pearson coefficient and for Moran's I were greater than 0.05, they were raised to the second power to eliminate the rare inverse correlation effect expressed in negative numbers. Subsequently, Moran's I squared to the Pearson coefficient squared ratio (which is a sub-case of) was used to calculate the Spatial Effect Index (SEI) proposed by the research team for each of the possible 10,890 pairings of parameters in the Atlas.

$$SEI = \frac{I_{ab}^2}{R_{ab}^2},$$

where I is the two-factor Moran's I for variables a and b ; R^2 is the coefficient of determination (linear correlation) between these two parameters.

Ten pairings with the highest spatial effect index for a given indicator are listed at the end of each subsection. Since the spatial effect is contained within the linear correlation of parameters, its ratio to Moran's I shows which pairings exhibit the highest spatial effect contribution to a phenomenon's distribution over the world's political map.

Table 1.2

Atlas indicators with the greatest spatial autocorrelation for geometric and geopolitical neighbourhood weights

Nº	Indicator	Moran's I (geometry)	Indicator	Moran's I (geopolitics)
1	HIV incidence	0.834	Passport power	0.621
2	Access to electricity	0.705	Regional trade agreements	0.596
3	Infant mortality	0.696	Access to electricity	0.578
4	Passport power	0.690	Infant mortality	0.571
5	Particulate air pollution	0.680	Particulate air pollution	0.546
6	Regional trade agreements	0.668	Young population	0.539
7	Elderly population	0.633	Maternal mortality	0.528
8	Maternal mortality	0.624	Institutional foundations of democracy	0.525
9	Publication activity	0.614	Number of doctors	0.512
10	Young population	0.595	Elderly population	0.510

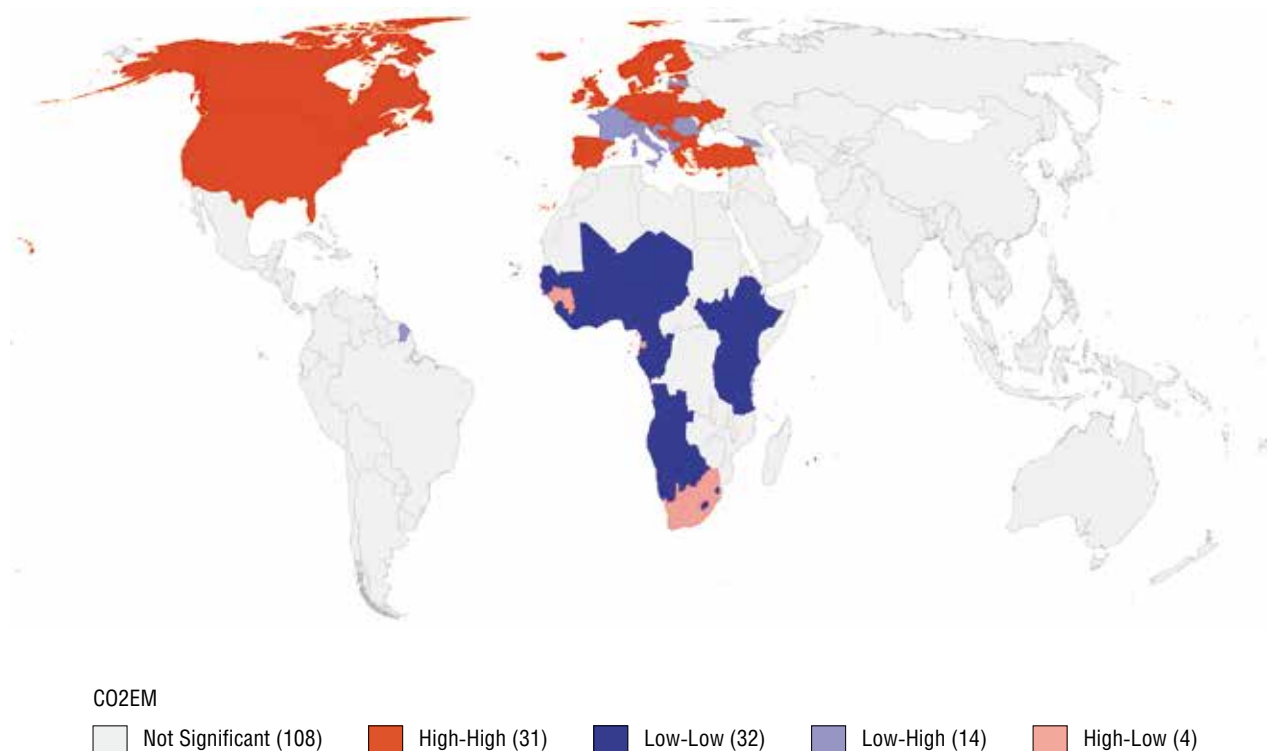


Fig. 1.7. Spatial autocorrelation cartogram for the emissions parameter in the geopolitical neighbourhood matrix

Geographically weighted regression (GWR). We applied regression analysis to our database of 110 indicators to identify the statistic dependence of each parameter's dispersion on the distribution of other parameters studied. We also used the geographically weighted regression method, which accounts for the spatial effect, or, in other words, demonstrates the degree to which spatial effects increase or reduce regressive dependence. For each section, we selected models that furnish the most reliable explanations of one dependent variable with account for the neighbourhood effect. We used two kinds of geographically weighted regression: the Spatial Autoregressive Model (SAR) and the Spatial Error Model (SEM). The Spatial Autoregression Model means that only neighbouring observations are used for regression, while the Spatial Error Model, on the contrary, excludes the neighbourhood factor from regression. The analysis used both geometric and geopolitical spatial neighbourhood weights matrices.

We used the following algorithm of selecting regression models. First, we used the research regression instrument in the ArcGIS Pro geoinformation system to select significant variables within each of the Atlas's 11 indicator groups (criteria: high significance [over 80%]; stable positive or negative predictors; no multicollinearity of indicators); the analysis algorithm in the software used replaced empty values with zero values. Subsequently, using selected indicators (no more than 40), we searched for models with two to five explanatory variables that meet the following criteria:

- the highest value of the adjusted R-squared and smallest value of the Akaike information criterion as proof that the model is the best fit for regression analysis;
- the p-value for all independent variables is less than 0.05, thus proving their significance for the model;
- the value of the Jarque–Bera test (normal distribution) is greater than 0.1 as proof of unbiased residuals;
- the Breusch–Pagan test as studentized by Koenker yielding a value of less than 0.05, thus proving regular distribution of residuals (no heteroskedasticity);
- the maximum value for the variance inflation factor (VIF) is less than 7.5, proving sufficiency of variables (no multicollinearity);
- the value of Moran's I for geometric neighbourhood weights is greater than 0.1, thus proving the absence of spatial autocorrelation of residuals;
- the value of the Lagrange multiplier or robust Lagrange multiplier (lag), or the value of the Lagrange multiplier or robust Lagrange multiplier (error) for geometric or geopolitical neighbourhood weights is less than 0.05 (i.e. for at least one out of the eight controlled calculations), proving the applicability of the geographically weighted regression model:
 - if any Lagrange multiplier proved valid for only one neighbourhood weight, we used only that weight for the GWR;
 - if only Lagrange multiplier (lag) proved valid, then we used the Spatial Autoregressive Model (SAR) for the GWR;
 - if only the Lagrange multiplier proved valid (error), then we used the Spatial Error Model (SEM) for the GWR;
 - if both Lagrange multipliers (lag and error) and only one robust Lagrange multiplier (lag) proved valid, we used the Spatial Autoregressive Model (SAR) for the GWR;
 - if both Lagrange multipliers (lag and error) and only one robust Lagrange multiplier (error) proved valid, then we used the Spatial Error Model (SEM) for the GWR;
 - if both Lagrange multipliers (lag and error) proved valid, while both robust Lagrange multipliers (lag and error) proved valid or invalid, then we chose the GWR with the highest value of robust Lagrange multiplier.

Linear regression models were mapped using standard deviation cartograms. Shades of red on the cartogram represent countries where the regression model has a higher-than-mean explanatory value; and shades of blue designate countries where it has a lower-than-global-mean explanatory value (in the latter case, it might signify that the regression model is not applicable to these countries).

After calculating 13.8 million regression models, we selected seven that meet all of the criteria described above. For each model, we compared three types of regression for validity and significance: non-spatial linear regression (Ordinary least squares, or OLS); geographically weighted regression with geometric neighbourhood weights matrix; and geographically weighted regression with geopolitical neighbourhood weights matrix. The following parameters were used:

- 1) the lower value of the Akaike information criterion as proof of greater validity in choosing between the geographically weighted and the non-spatial regressions;
- 2) the lower value of the Schwarz information criterion as proof of greater validity in choosing between geographically weighted regressions with different matrices of spatial neighbourhood weights;
- 3) the higher coefficient of determination (R-squared) as proof of a model's greater significance when choosing between geographically weighted regressions with different matrices of spatial neighbourhood weights.

Geographic average ellipses. We also used the method for mapping geographic average ellipses for the two- and three-factor analysis of worldwide spatial distribution of phenomena.

The geographic average is the average value of the x and y coordinates of all the objects within the scope of a given study. This method is used to compare the spatial distribution of various parameters (Fig. 1.8). Geographic average coordinates are calculated using the following formula:

$$\underline{X} = \frac{\sum_{i=1}^n x_i}{n}, \quad \underline{Y} = \frac{\sum_{i=1}^n y_i}{n},$$

where x_i and y_i are the coordinates for object i , while n is the total number of objects.

Centroids were used for polygonal objects when calculating distances. For multipartite polygonal countries, their centroids were calculated using the average weighted centres of all the parts of a given object. When determining the weights of polygonal objects, we accounted for their size. Calculations were made in ArcGIS Pro using the “mean center” tool.

Using data on the geographic average of a phenomenon's distribution, we built geographic average ellipses. Such ellipses are a standard method of measuring trends for a set of polygonal objects. The method is based on calculating standard distances separately for x-axis and y-axis (Fig. 1.9). Attribute-based values for the resulting elliptic polygons include x and y coordinates for the mean centre, two standards distances (the long and the short axes), and the orientation of the ellipse. We used one standard deviational ellipse that covers approximately 63% of all states with a higher concentration of objects in the centre and a lower concentration in the periphery (Rayleigh distribution). The following formula was used to calculate geographic average ellipses:

$$C = \begin{pmatrix} \frac{\text{var}(x)}{\text{cov}(y, x)} & \frac{\text{cov}(x, y)}{\text{var}(y)} \\ \frac{\text{cov}(y, x)}{\text{var}(y)} & \frac{\text{cov}(x, y)}{\text{var}(x)} \end{pmatrix} = \frac{1}{n} \begin{pmatrix} \sum_{i=1}^n x_i^2 & \sum_{i=1}^n x_i y_i \\ \sum_{i=1}^n x_i y_i & \sum_{i=1}^n y_i^2 \end{pmatrix},$$

$$\text{where } \text{var}(x) = \frac{1}{n} \sum_{i=1}^n (x_i - \underline{x})^2 = \frac{1}{n} \sum_{i=1}^n x_i^2,$$

$$\text{var}(y) = \frac{1}{n} \sum_{i=1}^n (y_i - \underline{y})^2 = \frac{1}{n} \sum_{i=1}^n y_i^2,$$

$$\text{cov}(y, x) = \frac{1}{n} \sum_{i=1}^n (x_i - \underline{x})(y_i - \underline{y}) = \sum_{i=1}^n x_i y_i,$$

where x and y are the coordinates of object i , while $\{\underline{x}, \underline{y}\}$ corresponds to the geographic mean centre of the objects, and n is their total number.

Calculations were performed in ArcGIS Pro using the “directional distribution (standard deviational ellipse)” tool. The cartogram shows the original ellipses used for analysis for the averaged NULL indicator (which equals 1 for all countries) and for the POPULATION indicator.

At the next stage, we calculated geographic averages and their ellipses for each of the 14 political and economic blocs used in the geopolitical matrix of spatial neighbourhood weights instead of the entire sampling of countries. First, we grouped countries into blocs and then calculated the geographic average for each bloc and mapped its distribution ellipse. The cartogram demonstrates the original ellipses used for analysis and plotted for geopolitical blocs using the statistically averaged NULL indicator (equals 1 for every country) and for the POPULATION indicator.

Geary’s multifactor local spatial autocorrelation coefficient (Geary’s C). To analyse the cumulative level of spatial autocorrelation within each group of ten indicators, we calculated Geary’s multifactor local spatial autocorrelation coefficient (Geary’s C) for both spatial neighbourhood weights matrices.

The following formula was used for calculations:

$$LG_i = \sum_j w_{ij} (x_i - x_j)^2.$$

The colour indigo in the resulting cartograms (Fig. 1.10) designates positive autocorrelation clusters (with similarly low statistical values), light blue designates negative spatial autocorrelation (with similarly high statistical values), grey designates clusters with p-value significance above the threshold, and black marks states for which there was no statistical data. Certain states that do not form spatial clusters with their neighbours were not analysed since their surroundings produced a significant statistical error. The cluster affiliation of the original isolate states on the geopolitical matrix of spatial neighbourhood weights (Israel, Iran, Mongolia, North Korea) was not described as “erroneous.”

As a rule, all ten indicators in the section were analysed with clusters mapped for both positive and negative values for Geary’s C with a p-value significance of less than 0.05 and with absent values replaced with zero values. However, in some cases, our research hypothesis demanded that only selected indicators be analysed for a group of indicators, that the p-value be increased to 0.1, and that the absent value not be replaced with zero values. All such adjustments are argued in the respective sections.

Inverse spatial cluster analysis. Since all spatial autocorrelation methods (global and local, single-factor, two-factor, and multifactor) used in the Atlas mostly focus on statistical similarities of neighbouring phe-

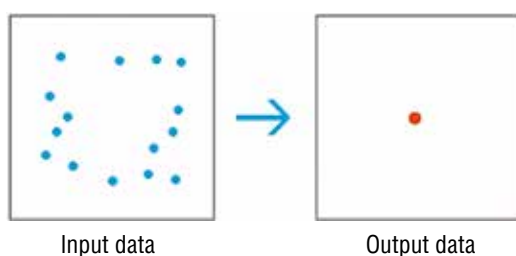


Fig. 1.8. Algorithm for calculating the geographic average

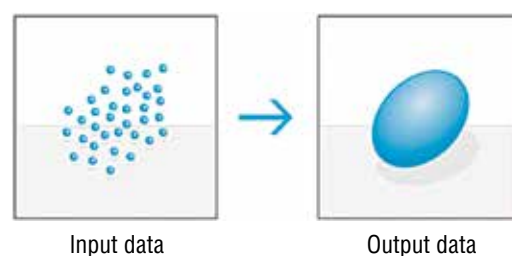


Fig. 1.9. Algorithm for calculating the geographic average ellipse

nomena, our research team developed a method for identifying and interpreting geographic exceptions, i.e. countries that exhibit maximum dissimilarity to their surroundings. This analysis was performed as part of inverse spatial cluster analysis using the k-median method for all the countries and the ten indicators in each section. Clustering uses selected variables to break the entire object set down into a series of statistical clusters, the number of which is determined by the researcher in such a way that the mean values for each variable exhibit maximum difference. Clustering was controlled for the geographic proximity factor. However, the weight of this factor (expressed in countries' geographic centroids) was set as 0%, 50% and 100% for three different cartograms. Clustering was performed by median values for $k = 14$ (the number of political and economic blocs in the geopolitical matrix of spatial neighbourhood weights). The clusters obtained were visualized on cluster cartograms.

Fig. 1.11 presents a cluster analysis cartogram based solely on countries' geometric centroids (their weights equalling 100% in the analysis). By comparing this cartogram to cartograms based solely on statistical similarity (where the weight of geometric centroids equals 0%) and with cartograms where geography and statistics had equal weight (50/50), the research team drew conclusions about countries that stand out from their clusters (i.e. about those countries that exhibit maximum dissimilarity to their neighbours) and, consequently, about the durability of the territorial clusters to which these countries belong.

Multidimensional scaling (MDS). Multidimensional scaling was used to reduce dimensionality in analysing the ten indicators in each section. This scaling allowed the research team to represent differences between objects as a two-dimensional dispersion chart. In other words, the closer two points are on a plot, the greater their similarity. Multidimensional scaling essentially foregrounds Tobler's first law of geography in its direct meaning.

In Euclidean (geographic) metric, for p variables, the distance between observations x_i and x_j in a p -dimensional space is defined as

$$d_{ij} = \|x_i - x_j\| = \sqrt{\sum_{k=1}^p (x_{ik} - x_{jk})^2}.$$

In this case, the objective of multidimensional scaling is to find points $z_1, z_2 \dots z_n$ in a two-dimensional space that will offer the highest correspondence to the distance between them in a multidimensional space. It is done using the following function:

$$S(z) = \sum_i \sum_j \left(d_{ij} - \|z_i - z_j\| \right)^2.$$

The resulting multidimensional scaling dispersion charts were analysed for concentrations (statistical clusters of countries) and were also used to identify countries that constitute exceptions. The United States, China and Russia were marked on all charts as the starting points of the analysis.

To better interpret multidimensional scaling, the research team plotted radar or spider charts as a means of simultaneously visualizing several statistical indicators on a plane. This method also uses spatial relations as a function of representing multidimensional statistical differences. Charts were plotted in the R Studio development environment for each indicator group (with the exception of the independents in the "Geography" section) for the three leading countries: Russia, the United States and China (Fig. 1.12). To calculate a country's position in the sample-based spectrum, the research team needed to calculate sample-based maximum and minimum indicator values with the difference between them being presented as 100% of the sample range. The R Studio language requires the strict use of non-negative values. Building these charts also requires translating all the omitted values into predicted mean values or zeros (in case of negative values or in case of it being impossible to assess predicted values).

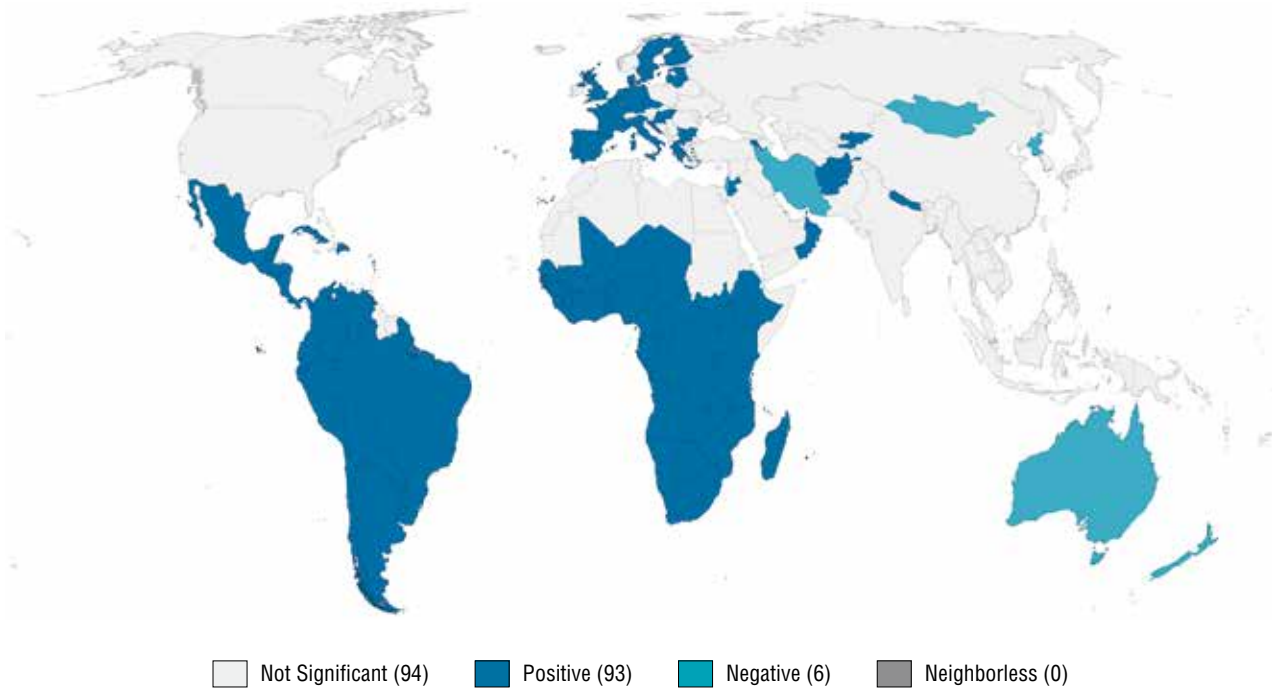


Fig. 1.10. Spatial autocorrelation cartogram for the “Demographics” section indicators for the geopolitical neighbourhood matrix

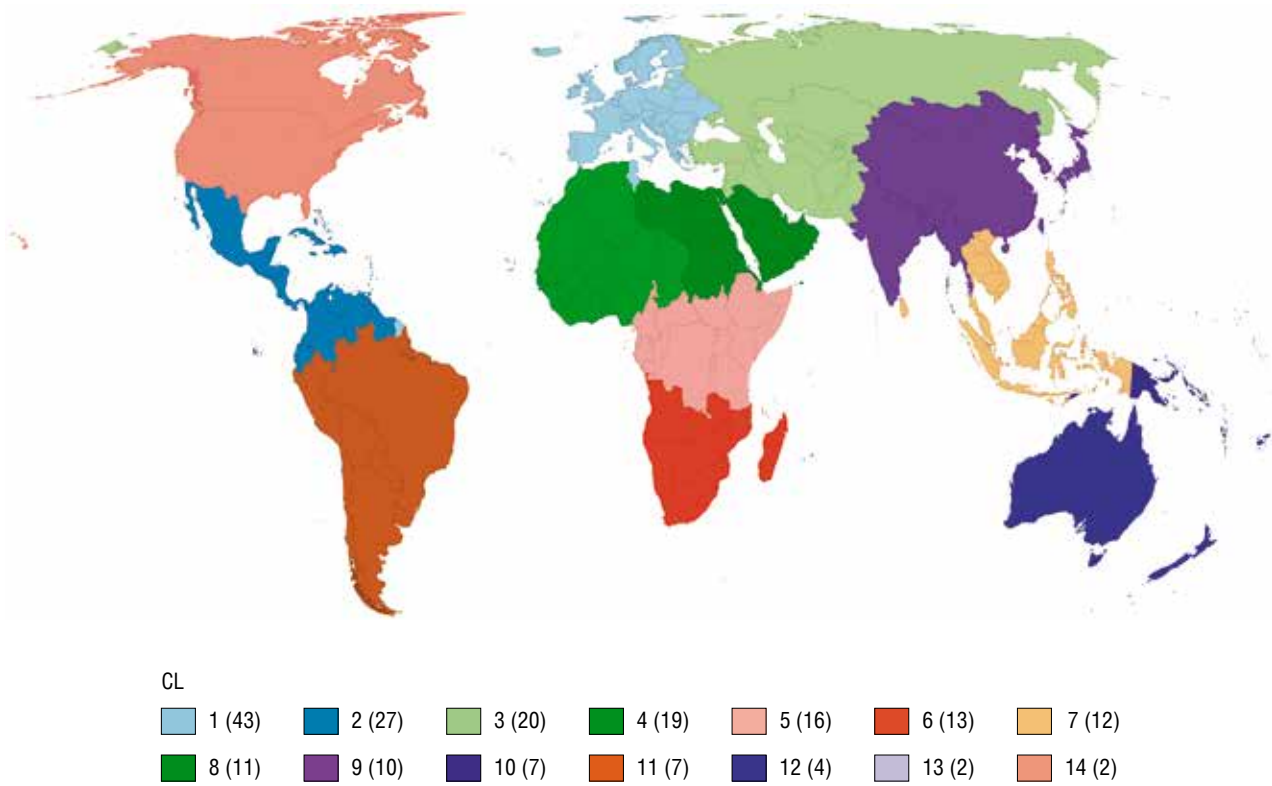


Fig. 1.11. Cluster analysis cartogram based solely on countries' geometric centroids

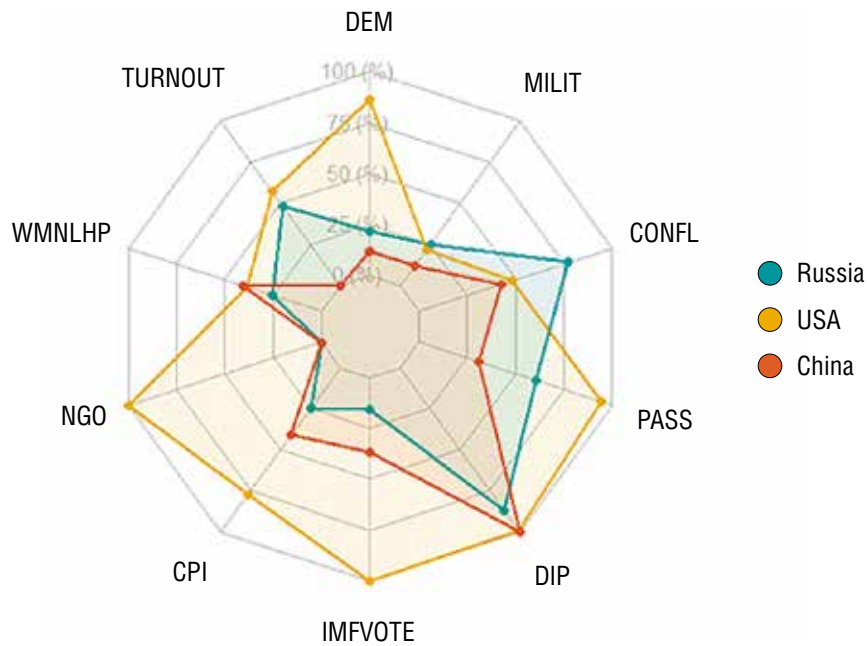


Fig. 1.12. Radar chart for the indicators from the “Politics” section

At the final research stage, inverse spatial cluster analysis and multidimensional scaling were applied to every one of the 100 indicators in the Atlas (with the exception of independent variables from the “Geography” section). Clustering was done by median values for with the weights of 0% and 50% for all geographical coordinates. The clusters obtained for $k = 2, 4, 5, 6, 8, 9, 12, 14, 18$ and 20 with the weights of geographical coordinates equal to 0% and 50% were visualized on cluster cartograms. In multidimensional scaling, the analysis focused on how countries in each of the 14 political and economic blocs from the geometric spatial neighbourhood weights matrix were distributed on the multidimensional scaling scatter plot for all the indicators in the Atlas. To illustrate our findings, we also plotted a three-dimensional multidimensional dispersion country chart for all the indicators in the Atlas.

This set of research techniques produced the findings expounded in the conclusion of each section of the Atlas and in the final chapters.

2

Demographics

Population density

Urbanization

Population growth

Infant mortality

Life expectancy

Young population

Elderly population

Female population

Marriage

Refugees

*Multifactor analysis of the “Demographics”
section indicators*

*Spatial factor for the “Demographics”
section indicators*

THE objective of this section is to describe population structure in as much detail as possible using the main elements that illustrate different aspects of human development.

Demographic analysis typically focuses on the gender and age population structure. The present section considers two age-related indicators. First, the researcher team selected the “Young population (population aged under 14)” indicator. Putting children and young people in a separate section among the overall population is important in studying long-term demographic, social, economic and political trends since a country’s development model is partially determined by the age structure of its population [Madsen, Daumerie & Hardee 2010]. An analysis of the ratio of different age groups in the structure of the population is also required for assessing and predicting long-term needs for infrastructure and resources, and the environmental effect.

Another widely used demographic indicator is dependency ratio — the ratio of those typically not in the labour force (children and pensioners) and those typically in the labour force.

It is a component of the human development index (HDI) and is actively used in demographic analysis. The dependency ratio serves to illustrate a society’s economic and demographic dependency. For this section, the team selected the so-called retirement burden coefficient, i.e. the elderly population demographic burden (the World Bank classifies the “elderly population” as people over 64). This indicator not only yields a fuller picture of population’s age structure [Morgan & Kunkel 2016], but also helps assess the effect a specific age structure has on socioeconomic trends.

“Life expectancy at birth” is traditionally included in the list of key human development indicators. This indicator is considered to be the most accurate among the HDI’s three principal components [Ghislandi, Sanderson & Scherbov 2019]. To better understand longevity trends with account for the effect mortality in different age groups has on overall life expectancy, the research team added another indicator to this section, namely, “Infant mortality rate.” In addition to this indicator affecting life expectancy, it can be seen as an indicator of social progress in other aspects that have important demographic significance (for instance, healthcare quality), and of social inequality level [Mirkin 2005].

To assess demographic trends, the research team selected an indicator measuring average annual population change rate — “Annual population growth” — which com-

prises three other demographic indicators: birth rate, mortality and migration. This indicator belongs with coefficients measuring the rate of demographic changes and is very important for social and demographic predictions [Vollset et al. 2020].

The “Female population” indicator (percentage of women in the total population) illustrates the gender structure of a given population and is required for a comprehensive analysis of gender equality, one of the main human development factors. Given the special significance that gender has for demographic trends, it would be wise to focus on such a demographic event as starting a family. This is reflected in the “Percentage of married women” indicator. This indicator, calculated by the UN Population Division using official statistics and census and survey data, is widely used to analyse marital and reproductive behaviour. It is affected by many factors, including the population’s age structure and education level, the level of women’s involvement in economic activities, the quality of social services, and population migration (Ono 2003). In turn, information about the percentage of married women is needed in order to analyse principal demographic trends and to make demographic predictions.

In addition to the traditional consideration of the population’s age and gender structure, a full-fledged analysis of human development potential requires other demographic characteristics to be studied as well. An important factor here is level of urbanization, which is generally considered to be a positive factor in, for instance, providing a general HDI assessment [Tripathi 2019]. Urbanization in this section is represented by the “Urban population percentage” indicator.

Another indicator that needs to be taken into account in addition to urbanization when looking at territorial population distribution is “Population density,” which measures the population to area ratio. Population density has a major effect on several socioeconomic indicators, including transportation infrastructure development, urbanization and economic behaviour models [Yegorov 2015].

Among the factors that increasingly affect demographic indicators and demographic trends is the number of people seeking or granted asylum. A large number of refugees in a host state affects income, education and life expectancy [Richmond 2008] and should be included in the analysis of the overall demographic picture.

2.1. Population density

Population density is measured as the average annual population divided by land area (in square kilometres). The population concept is based on the definition of population that includes all residents regardless of their legal status or citizenship (with the exception of refugees who temporarily stay in an asylum state and are generally counted with the population of their country of origin).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.005	0.356	-0.006	0.516
Geary's C	0.891	0.271	1.001	0.516

The percentile cartogram (Fig. 2.1.1) shows that the countries with high indicator values are situated in Europe (with the exception of Scandinavia), South and Southeast Asia, and in the Caribbean. Countries with the lowest indicator values are situated mostly in the north of Eurasia and America and in Africa. Australia is also a country with low population density. Such distribution is explained, among other things, by regional climate and environment.

It is noteworthy that the most densely populated countries demonstrate varying parameters, and that high density is caused by different factors: the small land areas of Monaco and Singapore, and extremely high population numbers in, say, India.

The median value is nearly four times smaller than mean value, which can be explained by two major outliers (Monaco and Singapore) that significantly change statistic distribution.

Given high statistic error indicator, it would not be a good idea to compare spatial correlation for geometric and geopolitical neighbourhood matrices.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.1.3) contains one particularly visible African cluster that crosses the continent from north to south. Another visible low-value

Global place	Country	Indicator (people per square kilometer)
1	Monaco	19,083.4
2	Singapore	7953
3	Bahrain	2017.3
Mean (29)	(Saint Lucia)	299.8674 (298.2)
Median (97)	Greece	83.3
191	Australia	3.2
192	Namibia	3
193	Mongolia	2

cluster in Latin America comprises Brazil, the La Plata states, and the Southern Cone countries. There are virtually no High-value clusters.

The geopolitical neighbourhood matrix cartogram (Fig. 2.1.4) features a low-value cluster spanning South America and Mexico (the MERCOSUR–LAIA bloc). Two clusters emerge in the south and centre of Africa (Southern African Customs Union/Southern African Development Community and the Economic Community of Central African States, or ECCAS), but no longer includes the north of the continent since the countries situated there form a political bloc with Middle Eastern countries, where the population density indicator values are distributed unevenly. Another cluster emerges in Southeast Asia (most ASEAN states). Distribution within the South Asian Association for Regional Cooperation (SAARC) presents an interesting combination of mutual exceptions.

The likelihood-ratio test for the “Population density” parameter (Fig. 2.1.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram clearly shows that neighbouring states manifest certain similarities in population density differentiation only in Central and Eastern Europe.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Internet users	0.028	0.023	0.110	0.432
2	Number of doctors	0.041	0.005	0.098	0.234
3	Publication activity	0.029	0.018	0.072	0.179
4	Urbanization	0.031	0.015	0.073	0.172
5	Capitalness	0.027	0.023	–0.053	0.104
6	Petrol prices	0.006	0.000	–0.015	0.037
7	Education spending	0.048	0.020	–0.030	0.019
8	Female population	0.027	0.025	–0.020	0.015
9	Bank deposits	0.036	0.017	0.014	0.005
10	Loans to domestic companies	0.024	0.041	0.010	0.004

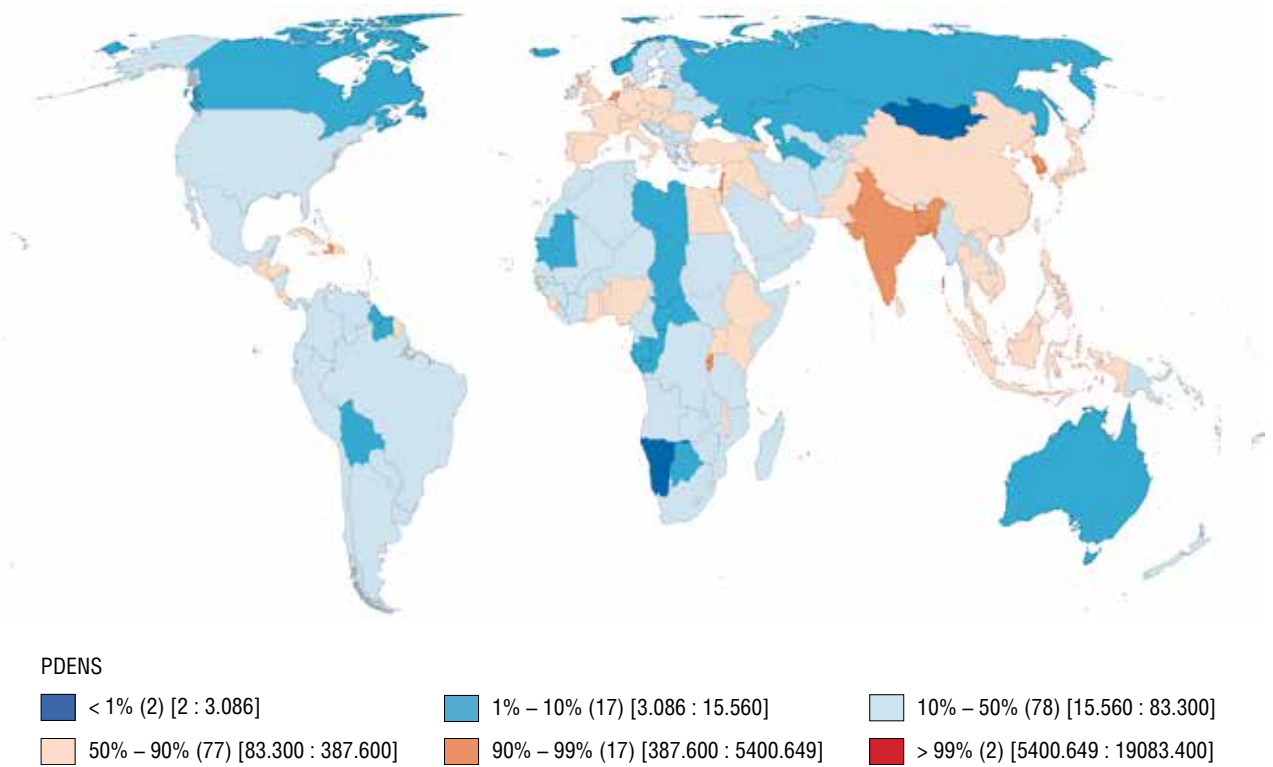


Fig. 2.1.1. Percentile cartogram for the “Population density” indicator

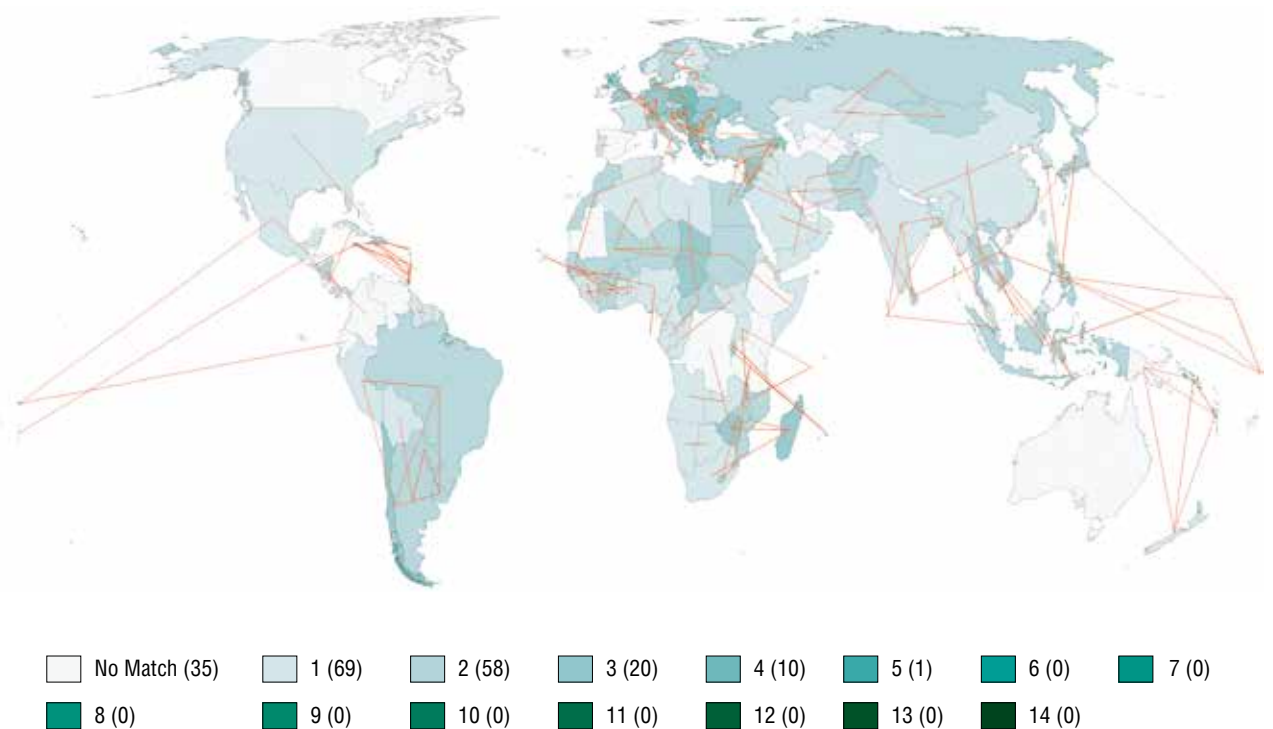


Fig. 2.1.2. Likelihood-ratio test for the “Population density” parameter

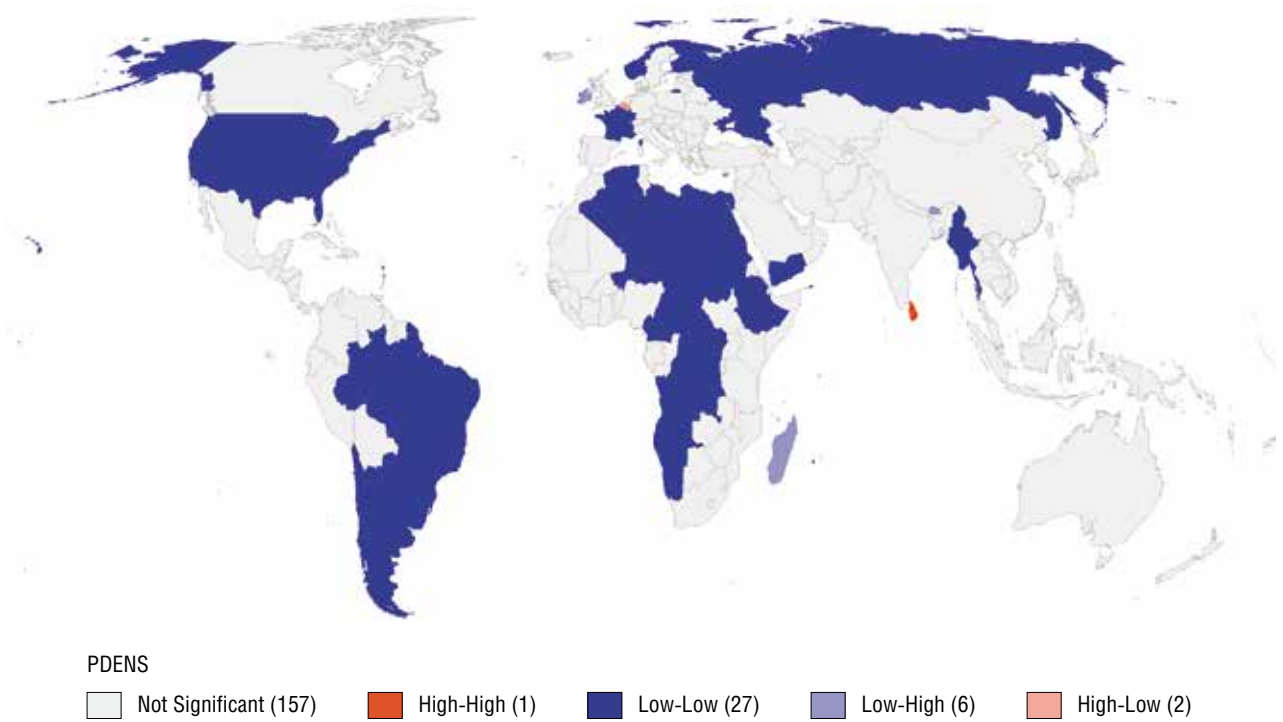


Fig. 2.1.3. “Population density” spatial autocorrelation cartogram for the geometric neighbourhood matrix

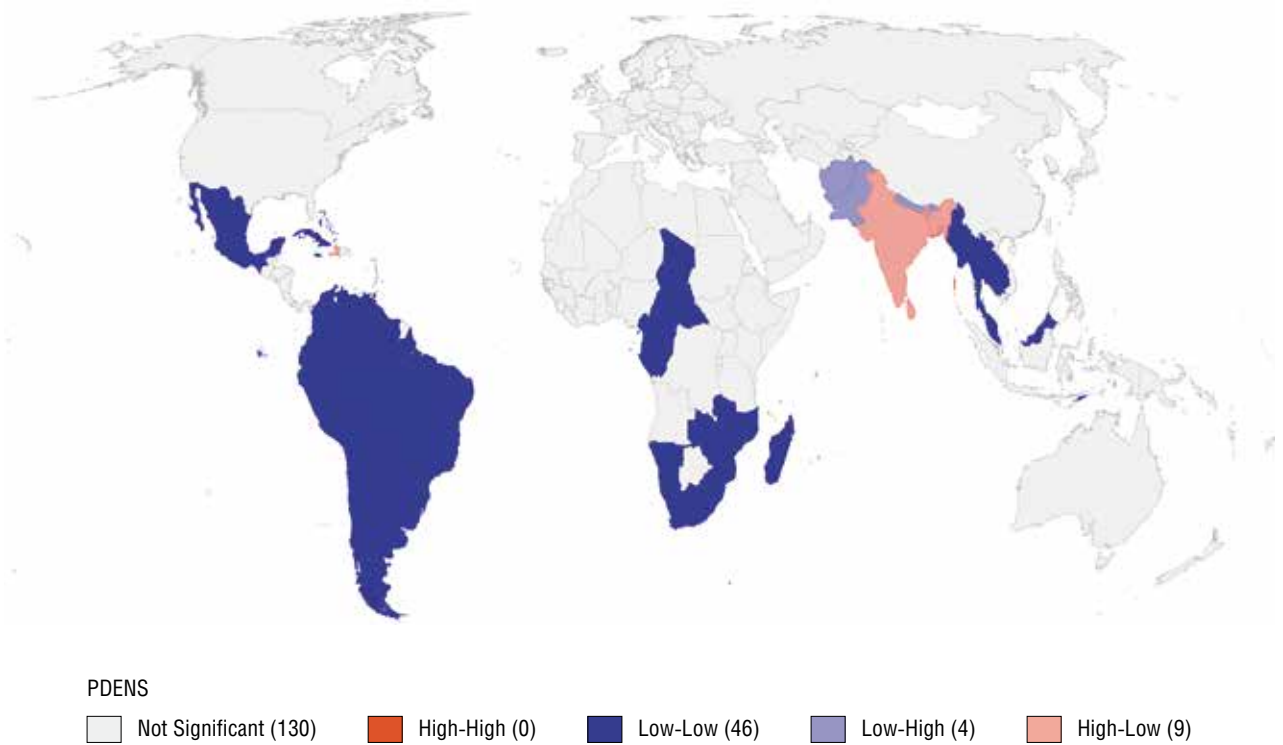


Fig. 2.1.4. “Population density” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.2. Urbanization

The “Urbanization” indicator represents the share of the urban population as a percentage of a country’s total population.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran’s I	0.435	0.000	0.352	0.000
Geary’s C	0.530	0.000	0.644	0.000

The percentile cartogram (Fig. 2.2.1) shows that countries with high indicator values (with the exception of some states in Central and Eastern Europe and the Balkans) are situated in Europe, North and South America, and some parts of Asia (China, North Korea, Mongolia, Iran, Iraq, Saudi Arabia). We should note in particular that the most highly urbanized states are located in different global regions. For instance, Japan, Singapore, Qatar, Kuwait and Israel are in Asia, Argentina and Uruguay are in South America, Gabon is in Africa, and Iceland, the Netherlands, Belgium and microstates are in Europe. Urbanization leaders are frequently states with a small area and a high population density. It is noteworthy that the urban population is larger than the rural population across the globe.

Countries with a low level of urbanization are mostly situated in South and Southeast Asia, the Caribbean, Central Africa and Oceania, i.e. primarily in developing states. However, it is worth noting that some African states may demonstrate hyper-urbanization, where the numbers of rural population striving to move to cities are so great that urbanization inevitably has perilous consequences.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world’s geopolitical structure has greater significance is thus not confirmed.

The most prominent cluster in the spatial autocorrelation cartogram for the geometric neighbourhood matrix (2.2.3) is the high-value cluster in South America, which is made up of Brazil, Argentina, Paraguay and

Global place	Country	Indicator (%)
1–4	Kuwait, Monaco, Nauru, Singapore	100
5	Qatar	99.10
6	Belgium	98
Median (96)	(China)	58.9 (59.2)
Mean (97)	(Georgia)	58.7297 (58.6)
190	Liechtenstein	14.3
191	Papua New Guinea	13.2
192	Burundi	13

Bolivia. Compared to its neighbours, Guyana stands out as a low-value state. High-value clusters are also situated in Western and Northern Europe.

A low-value urban population cluster emerged in East and Central Africa. At the same time, South Africa, even though its neighbours demonstrate low levels of urbanization, has a relatively high indicator value due, among other things, to people from neighbouring states migrating to developed South African cities. A low-value cluster in Asia includes India, which has low value neighbours, Myanmar and Thailand. China holds a special place in this respect, as the percentage of its urban population visibly exceeds the indicator values for its neighbouring states.

The geopolitical neighbourhood matrix cartogram (Fig. 2.2.4) shows a high-value cluster spanning the whole of South America, Mexico and Cuba, i.e. the LAIA–MERCOSUR bloc, and the Euro-Atlantic cluster where the countries of the former Yugoslavia, Romania, Slovakia and Austria stand out as exceptions.

In turn, Mauritania, Egypt, Sudan, Yemen and Syria drop out of the Arab states bloc as “errors.” A low-value cluster in Africa is formed from the member states of the East African Community. In the south of Africa, low value states neighbour on Angola, Botswana and South Africa, the most developed and urbanized states in the bloc.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Urbanization” parameter (Fig. 2.2.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. North America, the west of Africa, South Asia and the east of Europe also demonstrate a certain similarity in the urban population percentage in their respective neighbouring states. Curiously, the countries of the Middle East and North Africa are not at all similar in terms of urbanization levels.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Linguistic diversity	0.063	0.000	−0.247	0.968
2	Female labour	0.025	0.036	−0.148	0.876
3	Ethnic fractionalization	0.05	0.005	−0.198	0.784
4	Regional trade agreements	0.132	0.000	0.303	0.696
5	Cultural solidarity	0.102	0.000	0.255	0.638
6	Tuberculosis morbidity	0.114	0.000	−0.269	0.635
7	Highly wealthy population	0.042	0.011	−0.154	0.565
8	Inbound tourism	0.081	0.000	0.212	0.555
9	Infant mortality	0.288	0.000	−0.398	0.550
10	Population growth	0.07	0.000	−0.194	0.538

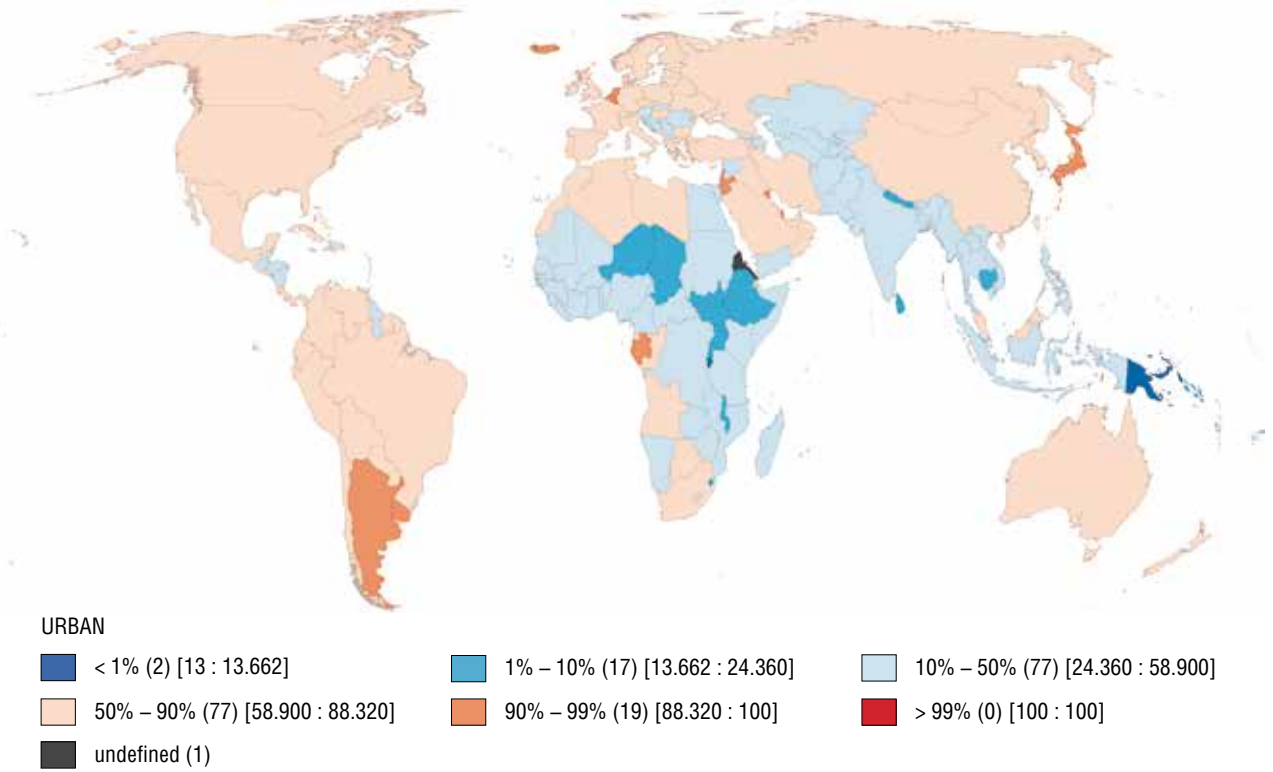


Fig. 2.2.1. Percentile cartogram for the “Urbanization” indicator

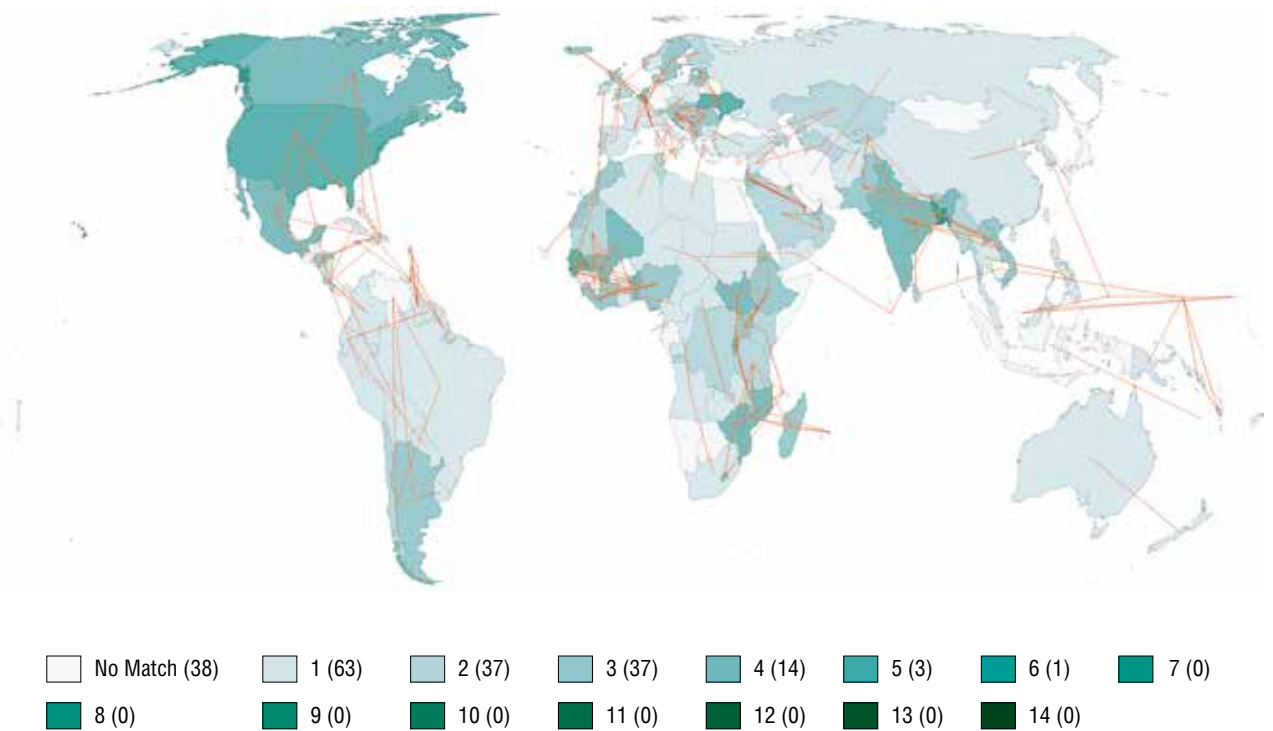


Fig. 2.2.2. Likelihood-ratio test for the “Urbanization” parameter

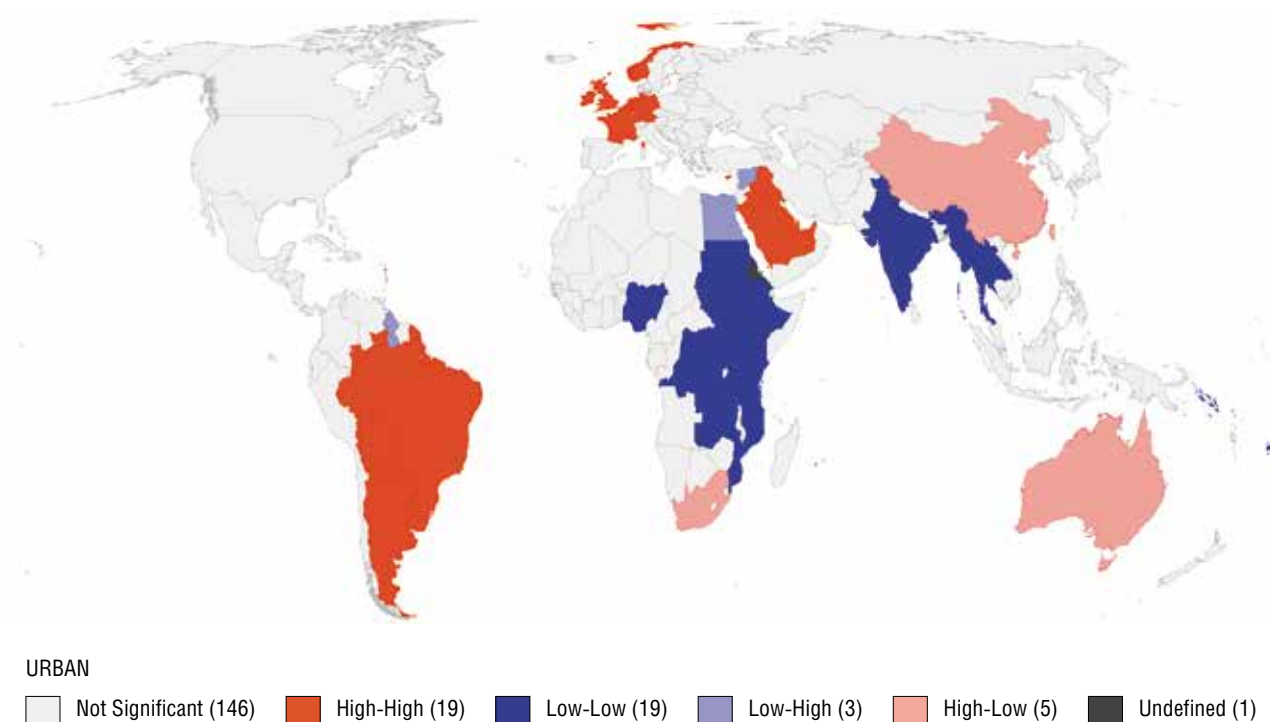


Fig. 2.2.3. “Urbanization” spatial autocorrelation cartogram for the geometric neighbourhood matrix

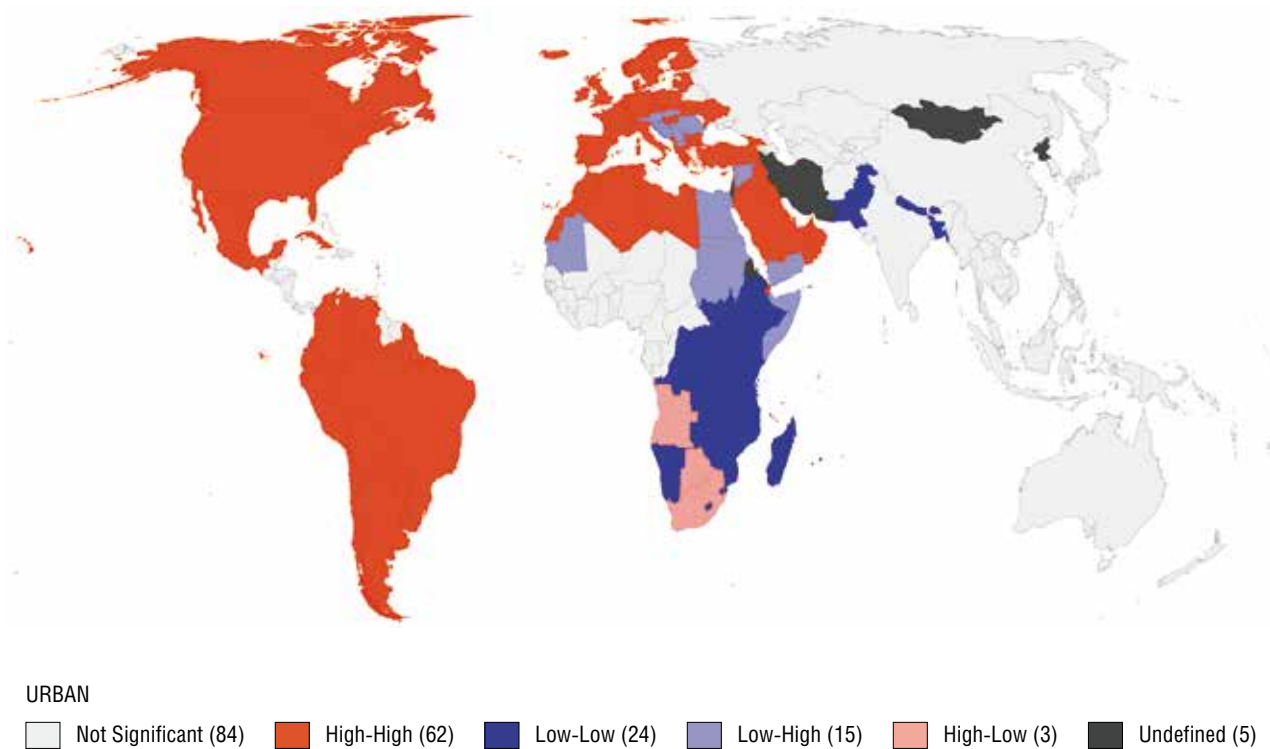


Fig. 2.2.4. “Urbanization” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.3. Population growth

The “Population growth” indicator describes the percentage of annual population changes. The value may be both positive and negative.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.574	0.000	0.394	0.000
Geary's C	0.422	0.000	0.603	0.000

The percentile cartogram (Fig. 2.3.1) shows that high population growth indicator values are typical for countries with traditional societies in Africa, Central Asia, the Middle East and the west of South America (the Andean countries). States with the lowest population growth percentages are mostly located in Europe, South America and the east of Asia. They include mostly industrial and post-industrial countries that have already completed or are completing a demographic transition. In some cases, low indicator values (for instance, in Venezuela and Syria) may be due to economic reasons or a protracted sociopolitical crisis, while high values (for instance, in Bahrain) may be due to the influence of immigration.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and in this instance, consequently, the hypothesis that the world's geopolitical structure has greater significance is not confirmed.

The most visible cluster in the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.3.3) is a group of high-value states that spans most Central, West, and East African countries and countries in some other sub-regions (Algeria in the north, Namibia in the south). A low-value cluster emerged in Central and Eastern Europe (including Russia and some Southern European states) characterized by low birth rates and low migration increase.

Global place	Country	Indicator (%)
1	Bahrain	4.9
2–3	Maldives, Niger	3.8
4–5	Uganda, Equatorial Guinea	3.7
Mean (90–94)	(Haiti, Kazakhstan, Morocco, Nicaragua, Paraguay)	1.2792 (1.3)
Median (95–100)	Bhutan, Ireland, Cabo Verde, Tonga, Tuvalu, Sweden	1.2 (1.2)
188–189	Lithuania, Syria	–1
190	Nauru	–1.3
191–192	Venezuela, Moldova	–1.8

The geopolitical neighbourhood matrix cartogram (Fig. 2.3.4) shows high-value clusters in all geopolitical blocs in Africa, but there are intra-bloc exceptions, such as Lesotho and Eswatini in the south, and South Sudan in the east. A high-value cluster is also formed by the Arab states, with the exception of Tunisia and Syria. The Euro-Atlantic cluster is made up of low values, but it also has exceptions, such as Canada, Luxembourg, Iceland, Malta and Turkey, whose values place it closer to its Middle Eastern neighbours.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Population growth” parameter (Fig. 2.3.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The densest nodes of similar values among neighbours are observed in Eastern Europe and in the west of Africa. Similar values can also be seen in neighbouring states in other parts of Africa (apart from its north), Central Africa and Southeast Asia.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Maternal mortality	0.23	0	0.49	1.044
2	Regional trade relations	0.167	0	-0.412	1.016
3	Forest areas	0.025	0.029	-0.157	0.986
4	Institutional foundations of democracy	0.146	0	-0.373	0.953
5	Passport power	0.28	0	-0.506	0.914
6	Publication activity	0.102	0	-0.305	0.912
7	Economic inequality	0.078	0	0.25	0.801
8	Alcohol consumption	0.198	0	-0.398	0.800
9	Particulate air pollution	0.287	0	0.473	0.780
10	Infant mortality	0.309	0	0.488	0.771

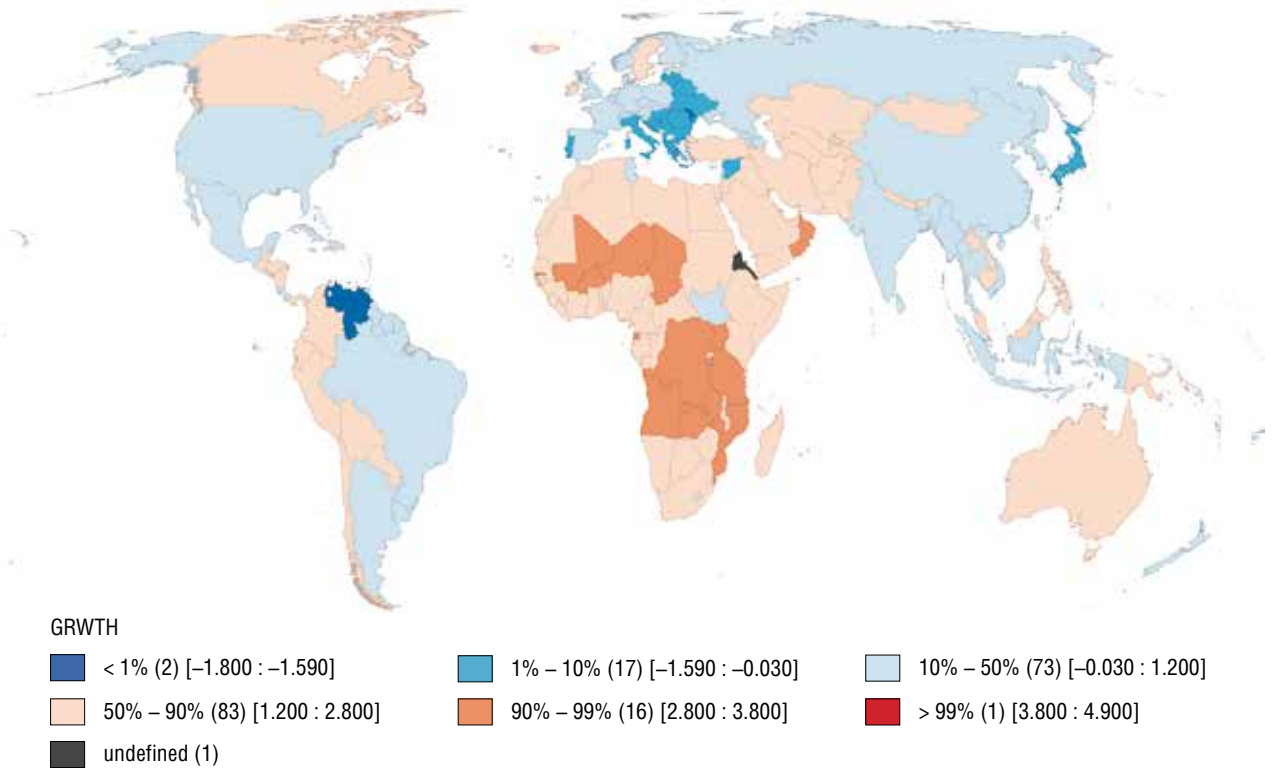


Fig. 2.3.1. Percentile cartogram for the “Population growth” indicator

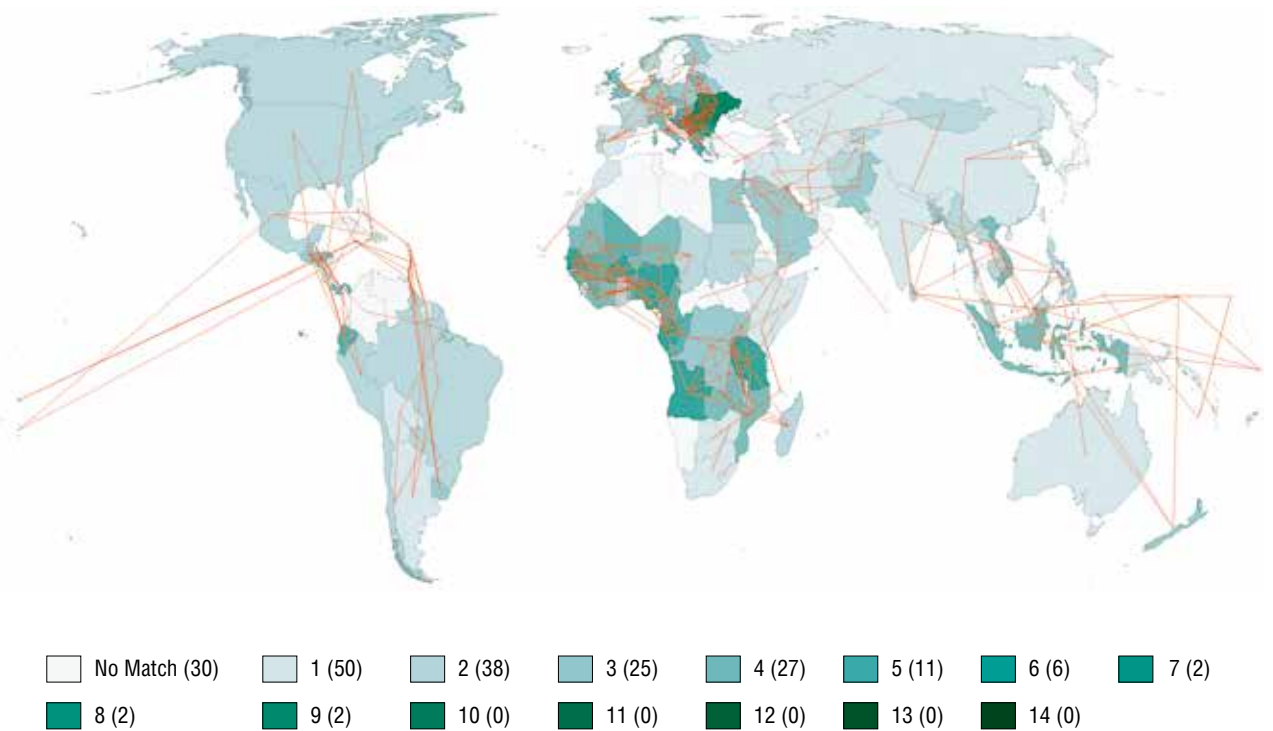


Fig. 2.3.2. Likelihood-ratio test for the “Population growth” parameter

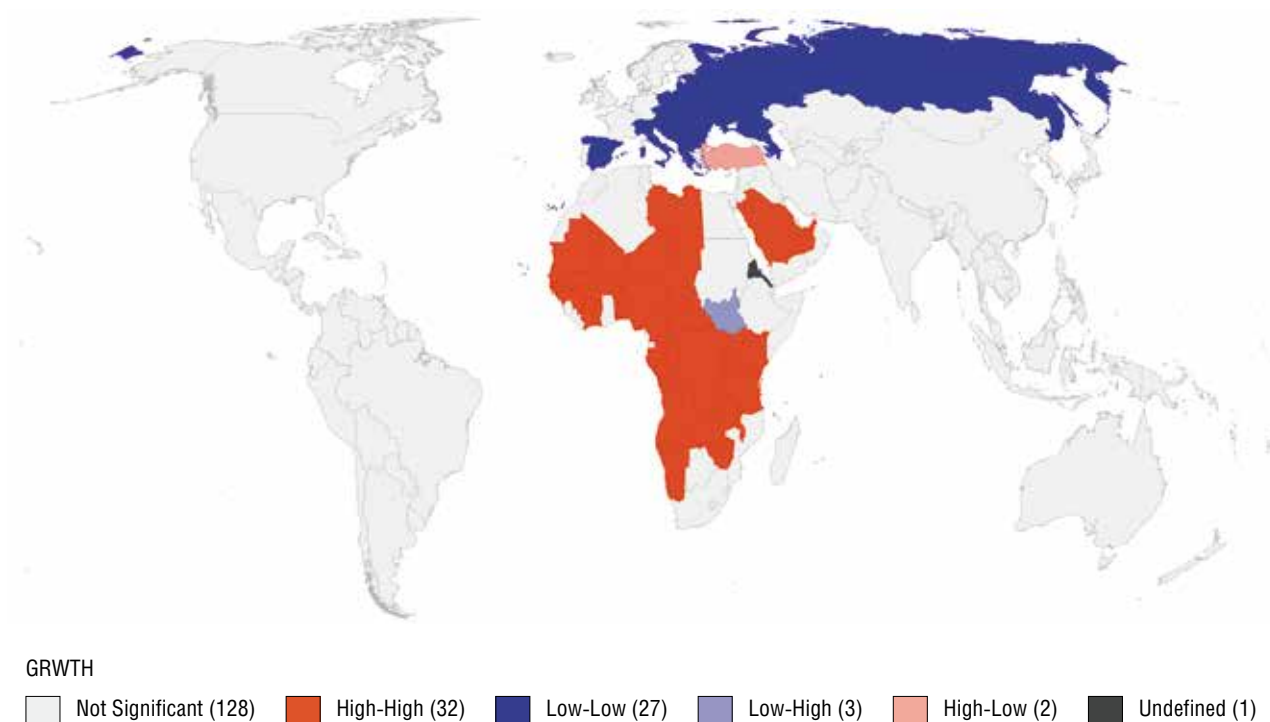


Fig. 2.3.3. “Population growth” spatial autocorrelation cartogram for the geometric neighbourhood matrix

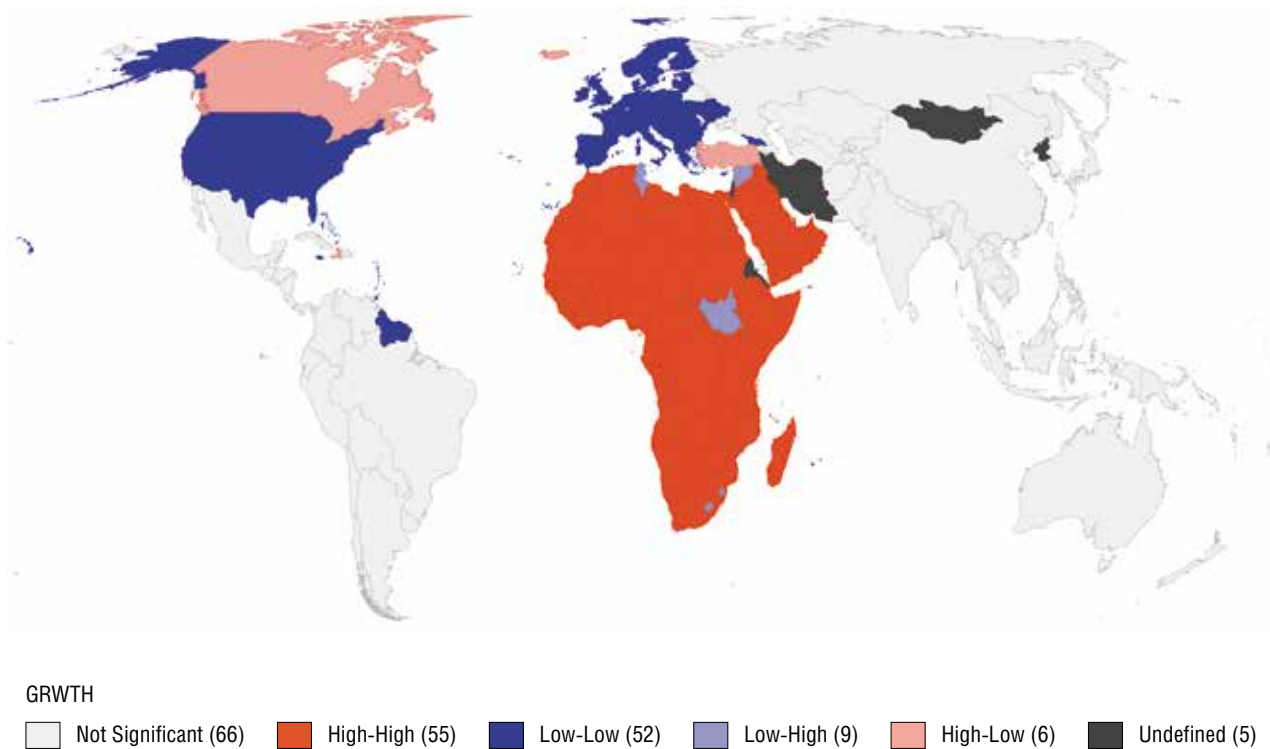


Fig. 2.3.4. “Population growth” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.4. Infant mortality

Infant mortality rate is the number of deaths per 1000 live births of children under one year of age.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.696	0.000	0.571	0.000
Geary's C	0.296	0.000	0.426	0.000

The percentile cartogram shows that states with high infant mortality rates are located in Africa and South Asia, with the highest values observed in the countries of Central and West Africa.

The countries with the lowest infant mortality rates (Fig. 2.4.1) are mostly situated in Northern and Southern Europe (and Japan), while low values are largely typical for the European continent, most states of America, and Australia and New Zealand. Indicator values in a particular country/region are explained by both the quality and accessibility of healthcare, and by the overall level of social and economic development.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and in this instance, the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.4.3) clearly shows two clusters: a high-value cluster in Africa (with the exception of the continent's north) and a low-value cluster in Europe, including Russia.

The geopolitical neighbourhood matrix cartogram (Fig. 2.4.4) shows a high-value cluster that spans virtually the entire African continent, with the exception of certain areas that include members of associations of Arab states. "Low-high" exceptions with low indicator values (unlike the high values among their neighbours) are observed in island states: Mauritius, the Seychelles and Cabo Verde.

Global place	Country	Indicator
1–2	Sierra Leone, Central African Republic	83.4
3	Somalia	75.9
4	Nigeria	75.7
Mean (73)	(Fiji)	21.5760 (21.6)
Median (96)	(Tonga)	14.3 (14.4)
189	Japan	1.8
190	Slovenia	1.7
191–192	Iceland, San Marino	1.6

Developed states in Europe and North America, in turn, form a cluster of countries with low infant mortality rates. No geopolitical clusters are observed in Asia.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Infant mortality” parameter (Fig. 2.4.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram clearly shows a high concentration of indicator connectedness in Europe and West Africa and among the Caribbean countries and some Southeast Asian states.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Ethnic minorities	0.045	0.005	0.221	1.085
2	Suicide rate	0.047	0.005	−0.211	0.940
3	IMF voting power	0.051	0.002	−0.219	0.928
4	Linguistic diversity	0.225	0	0.457	0.870
5	Cultural solidarity	0.16	0	−0.373	0.852
6	Population growth	0.309	0	0.513	0.797
7	Light pollution	0.029	0.021	−0.152	0.716
8	Regional trade relations	0.272	0	−0.464	0.785
9	Economic inequality	0.124	0	0.312	0.759
10	Ethnic fractionalization	0.239	0	0.426	0.752

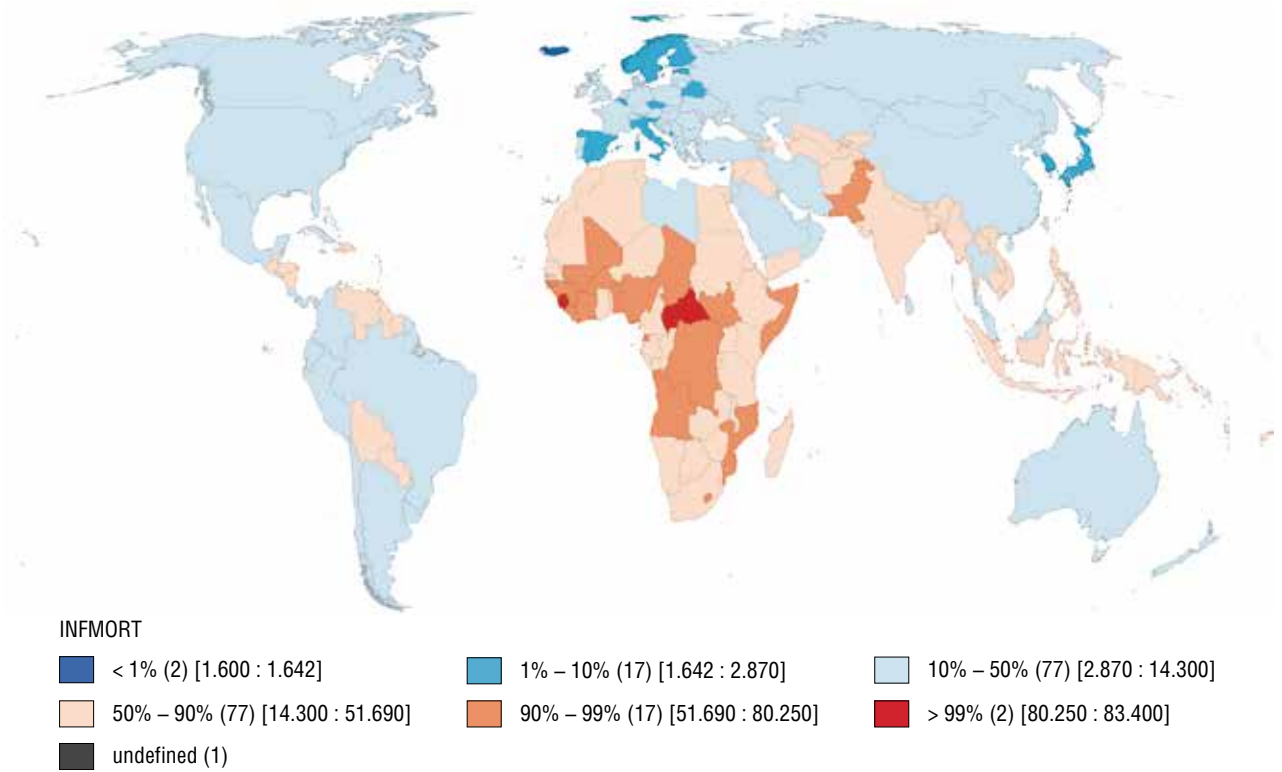


Fig. 2.4.1. Percentile cartogram for the “Infant mortality” indicator

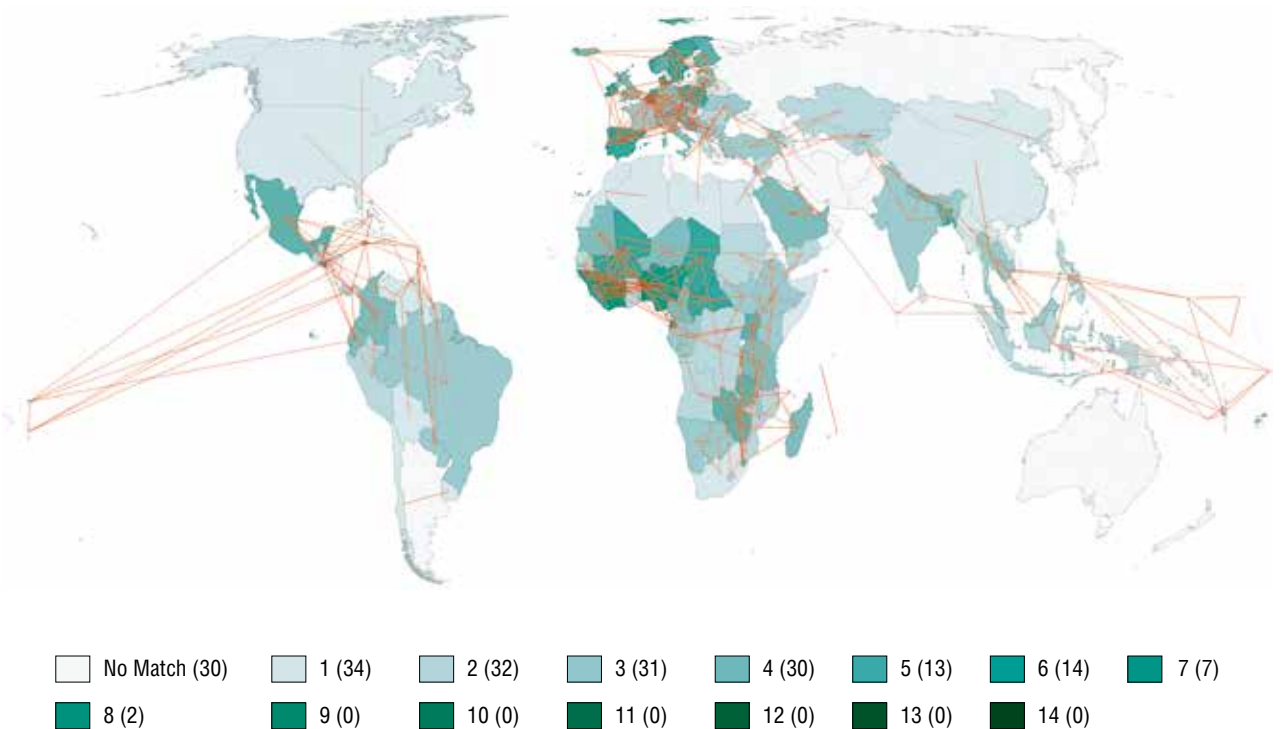


Fig. 2.4.2. Likelihood-ratio test for the “Infant mortality” parameter

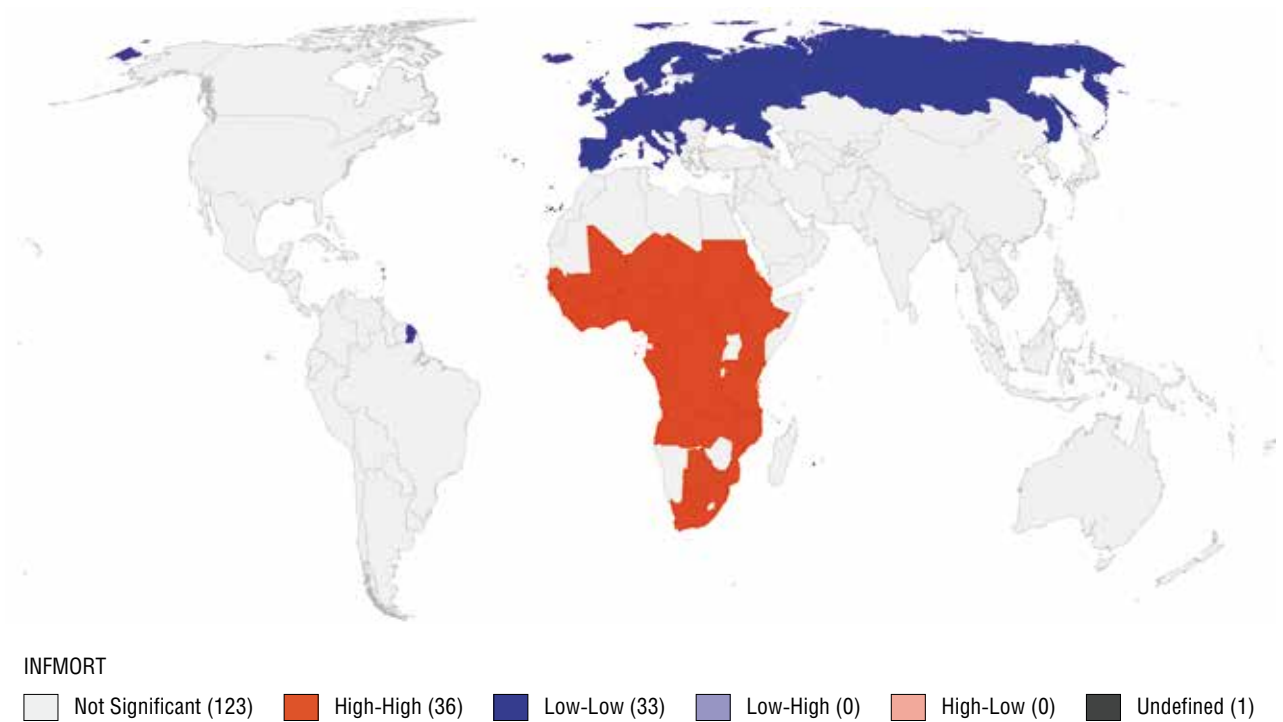


Fig. 2.4.3. “Infant mortality” spatial autocorrelation cartogram for the geometric neighbourhood matrix

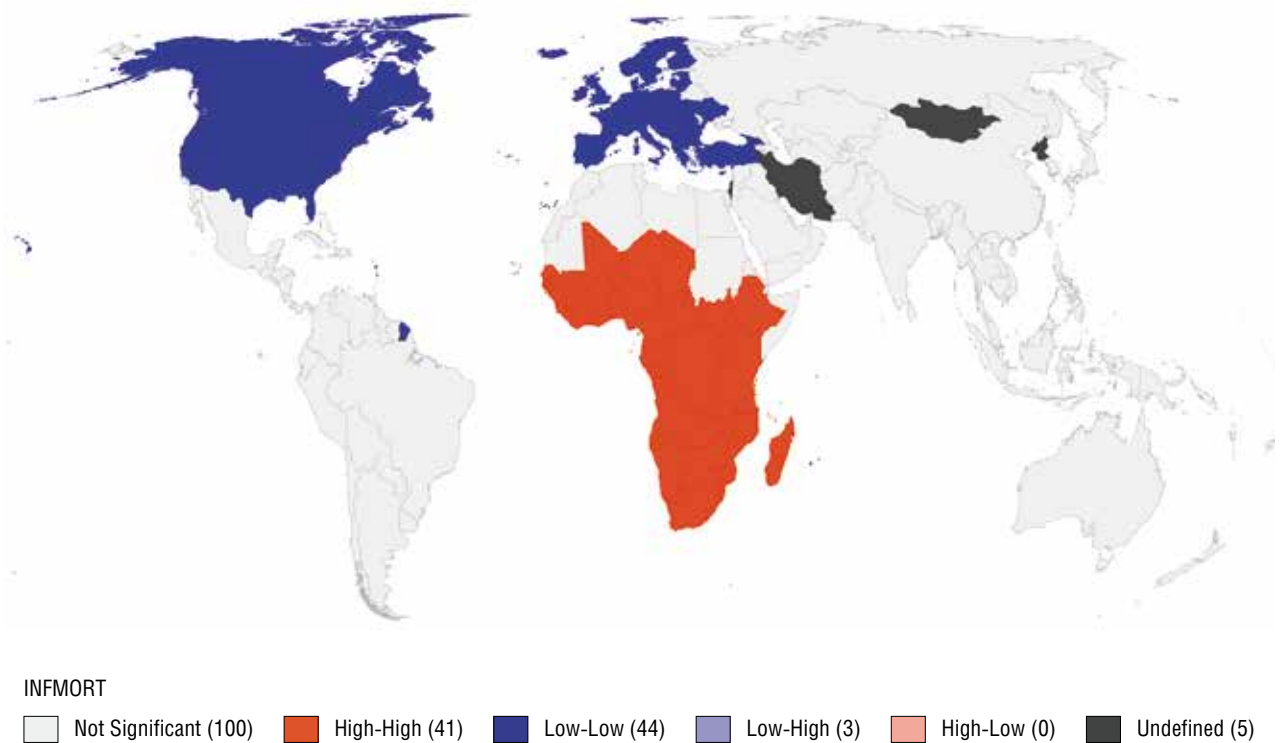


Fig. 2.4.4. “Infant mortality” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.5. Life expectancy

The “Life expectancy” indicator measures life expectancy at birth, i.e. the number of years a newborn is expected to live if the prevailing mortality models at the time of their birth remain the same throughout their life.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.254	0.000	0.138	0.000
Geary's C	0.718	0.000	0.858	0.000

The percentile cartogram (Fig. 2.5.1) shows that countries with the highest indicator values are concentrated in Europe. Additionally, Japan, South Korea, Canada, Australia and Israel also have high indicator values. Countries with the lowest life expectancy are situated in Africa, mostly in the central regions of the continent. Many Asian countries also demonstrate relatively low values of this indicator. Arab states demonstrate high indicator differentiation: while most Gulf states have a high life expectancy, low values are recorded in Libya, Syria, Iraq and Yemen (countries that have suffered from armed conflicts), as well as in Egypt. Low life expectancy is also typical for most post-Soviet states.

This indicator demonstrates moderate spatial correlation with the geographic matrix yielding a slightly greater spatial correlation than the geopolitical one.

Two clusters stand out on the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.5.3): a European cluster of high indicator values and an African cluster of low indicator values. The European cluster clearly forms a boundary between the countries of Western and Eastern Europe. Curiously, Morocco forms part of this cluster. The low-value cluster in Africa spans virtually the entire continent, with the exception of Arab states in the north and several states in East Africa. Micro-clusters also emerged in the Caribbean, but they comprise a small number of states.

Global place	Country	Indicator (years)
1	Japan	84.2
2	Switzerland	83.8
3	Spain	83.4
Median (92)	(Trinidad and Tobago)	73.3 (73.4)
Mean (104)	(Bangladesh)	72.2120 (72.3)
182	Chad	54.0
183	Lesotho	53.7
184	CAR	52.8

The only “error” is Syria, where life expectancy is lower than in its neighbour states, which clearly evidences the consequences of the ongoing armed conflict.

The geopolitical neighbourhood matrix cartogram (Fig. 2.5.4) shows similar clusters, but their composition is slightly different. The European cluster becomes a Euro-Atlantic cluster that includes the United States and Canada and expands eastwards. The only exception in this bloc is Ukraine, where life expectancy is lower than in other European countries. At the same time, Morocco is no longer part of this cluster since it belongs to another political bloc. The latter does not form a cluster since the life expectancy among its member states varies greatly.

The African cluster is made up of several geopolitical blocs and practically repeats the geometric matrix clustering (with the exception of Sudan, which, like Morocco, belongs to the bloc of Arab states). Therefore, several African integration alliances prove to have a homogeneous composition when compared by their life expectancy indicator. In both cases, no large clusters emerge in Asia or Latin America.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Life expectancy” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram (Fig. 2.4.4) clearly shows two sub-clusters in Europe (Eastern and Western Europe), with Canada leaning toward the latter. Sub-Saharan clusters of countries with low life expectancy values are even more visible, while no connection node emerges in the north of the continent. The Caribbean demonstrates an example of rather close connections, although, no clusters emerge in South America as a whole.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Female labour	0.028	0.026	−0.222	1.760
2	Suicide mortality	0.025	0.042	0.168	1.129
3	Population growth	0.259	0	−0.495	0.946
4	Linguistic diversity	0.25	0	−0.471	0.887
5	IMF voting power	0.077	0	0.259	0.871
6	Ethnic minorities	0.058	0.001	−0.222	0.850
7	Cultural solidarity	0.191	0	0.399	0.834
8	Economic inequality	0.162	0	−0.364	0.818
9	Light pollution	0.029	0.023	0.151	0.786
10	Highly wealthy population	0.216	0	−0.407	0.767

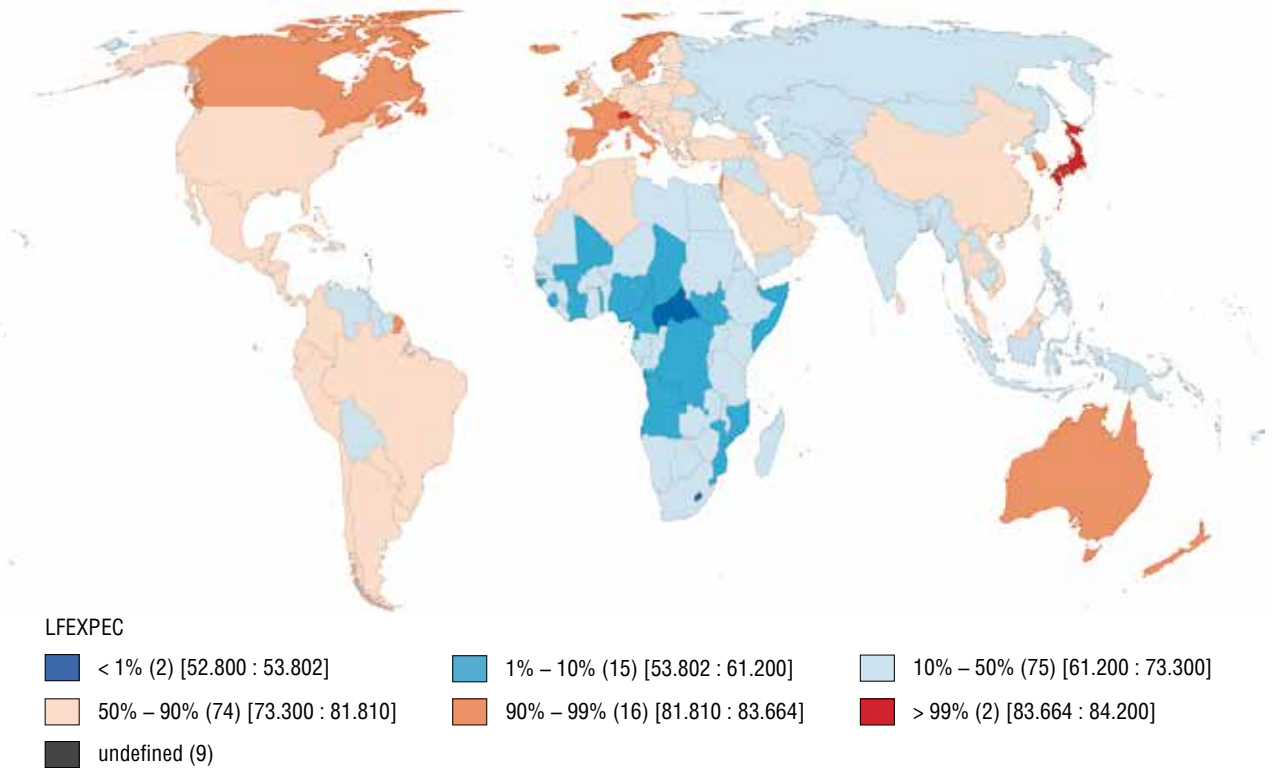


Fig. 2.5.1. Percentile cartogram for the “Life expectancy” indicator

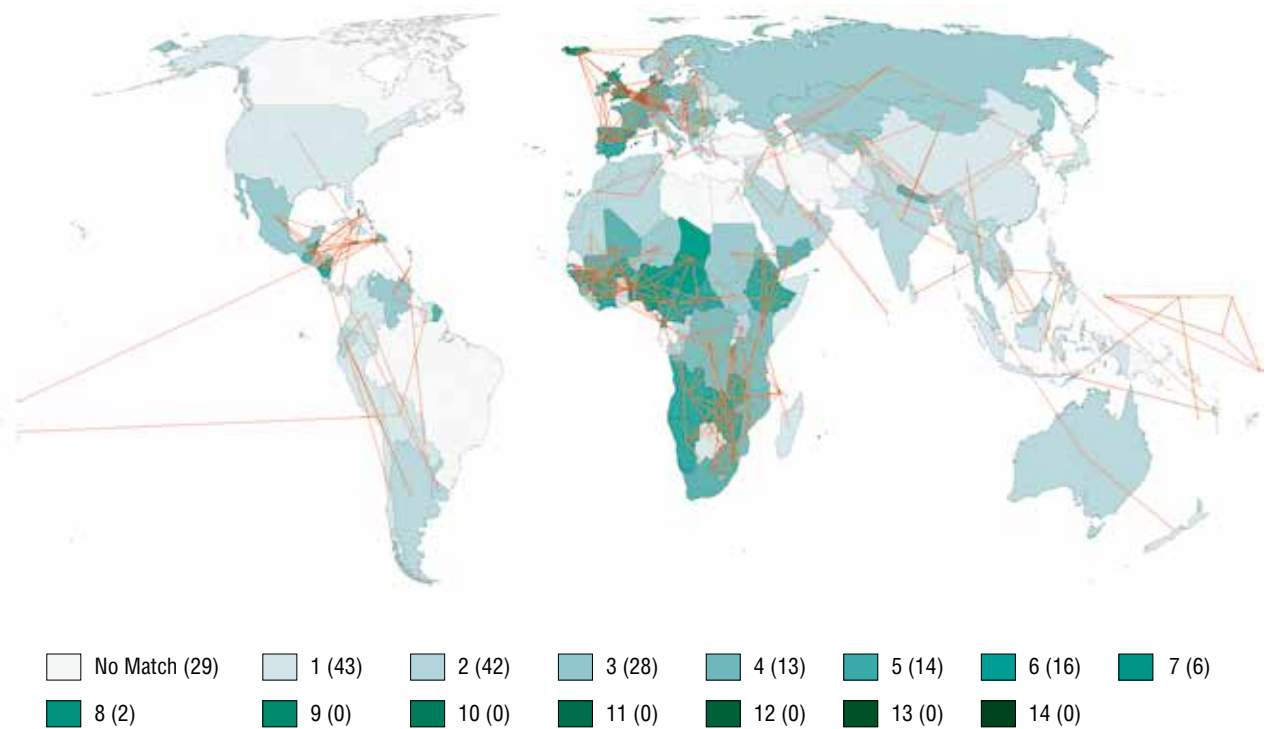


Fig. 2.5.2. Likelihood-ratio test for the “Life expectancy” parameter

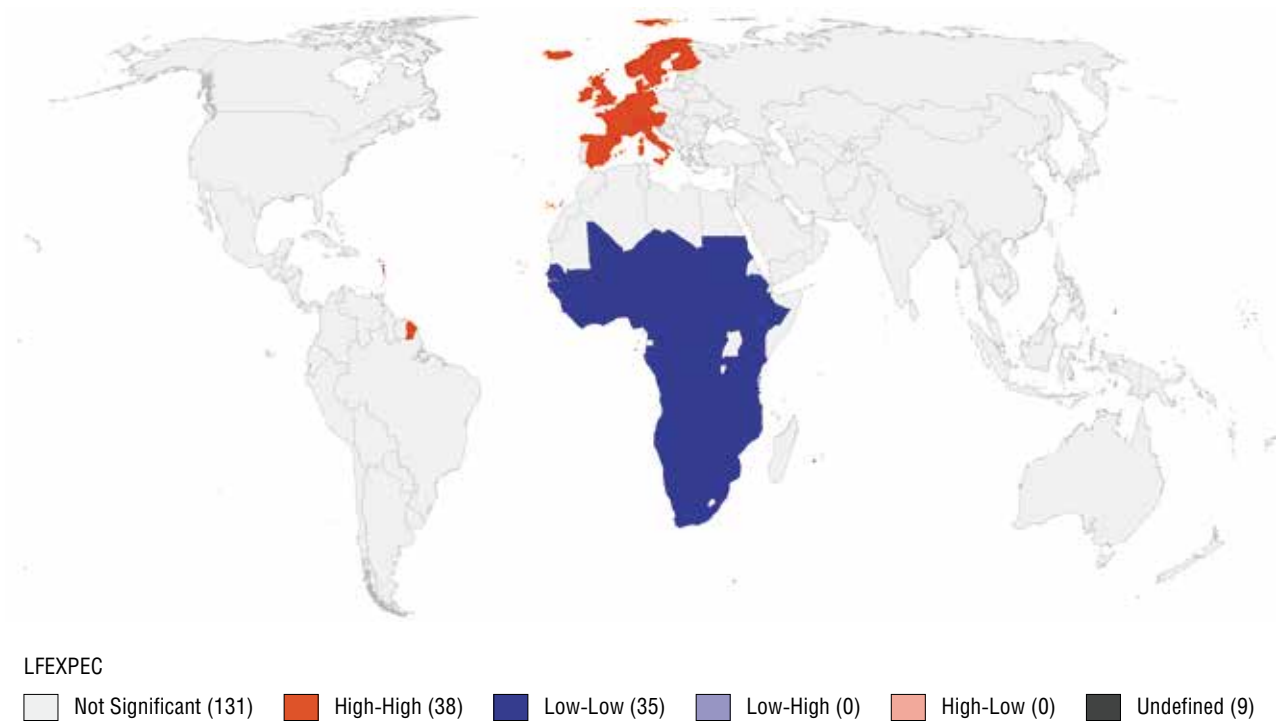


Fig. 2.5.3. “Life expectancy” spatial autocorrelation cartogram for the geometric neighbourhood matrix

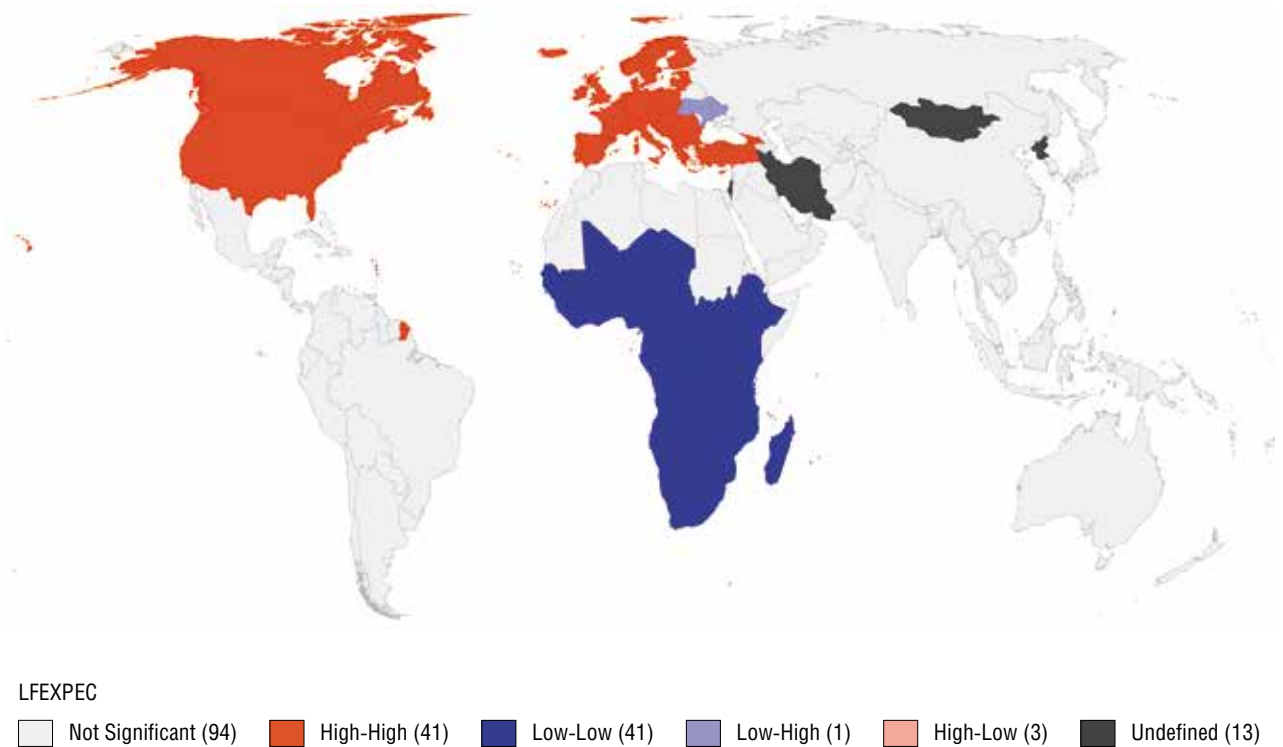


Fig. 2.5.4. “Life expectancy” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.6. Young population

The “Young population” indicator measures the percentage of population aged 0–4 in the total population.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.595	0.000	0.539	0.000
Geary's C	0.396	0.000	0.458	0.000

The percentile cartogram (Fig. 2.6.1) shows that countries with high indicator values are situated mostly in Africa and in some Asian regions (Central Asian states, Nepal, Iraq, Syria, Jordan, Bangladesh, the Philippines, Mongolia, Laos, Cambodia). Countries with low indicator values are situated in Europe, America and East Asia. This distribution of the percentage of children in the overall population stems, first, from differences in birth rates (high natural population increase rates in Africa and negative figures in Europe) and, second, from differences in other social attributes (quality of life, healthcare quality, life expectancy, etc.). Consequently, developed countries in the north have greater percentages of other age groups, primarily the elderly population.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and in this instance, the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.6.3) clearly shows two clusters: a southern cluster with high indicator values in Africa and a northern cluster of low values that has formed in Europe stretching from France to Russia. However, this cluster does not include the Scandinavian countries, the British Isles, and some states of Southern Europe.

Global place	Country	Indicator (%)
1	Niger	49.9843
2	Mali	47.5
3	Chad	47.1
Mean (85)	(Israel)	27.8380 (27.9252)
Median (92)	(India)	27.0578 (27.0533)
180	South Korea	13
181	Japan	12.7
182	Singapore	12.3

The geopolitical neighbourhood matrix cartogram (Fig. 2.6.4) also features northern and southern clusters. The northern (low-value) cluster is now formed by all European states, including the United States, Canada and Turkey. Russia, which belongs to a different geopolitical bloc, does not form a cluster with its neighbours.

A high-value cluster in Africa spans all countries that are members of different geopolitical alliances, except for those that are members of the bloc of Arab states, and two exceptions — Mauritius and the Seychelles. Neither matrix has a Latin American or Asian cluster, since in these regions, both geographic neighbours and members of geopolitical alliances exhibit significant differentiation for the indicator under consideration.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Young population” parameter (Fig. 2.6.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram shows that the densest correlations are typical for most European states (particularly in Eastern Europe) and in sub-Saharan Africa. Indicator value proximity can be observed among the neighbours in the Caribbean. There are virtually no connections between neighbours in North Africa, the Middle East and Central Asia.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator in question.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Linguistic diversity	0.246657	0	0.473	0.907
2	Ethnic fractionalization	0.217635	0	0.428	0.841
3	Cultural solidarity	0.165194	0	0.365	0.806
4	Economic inequality	0.181995	0	0.382	0.802
5	Light pollution	0.034007	0.014	-0.163	0.782
6	IMF voting power	0.077774	0	-0.246	0.778
7	Highly wealthy population	0.234161	0	0.424	0.768
8	Women in politics	0.03253	0.015	-0.156	0.748
9	Ethnic minorities	0.093984	0	0.262	0.730
10	Population growth	0.500339	0	0.603	0.727

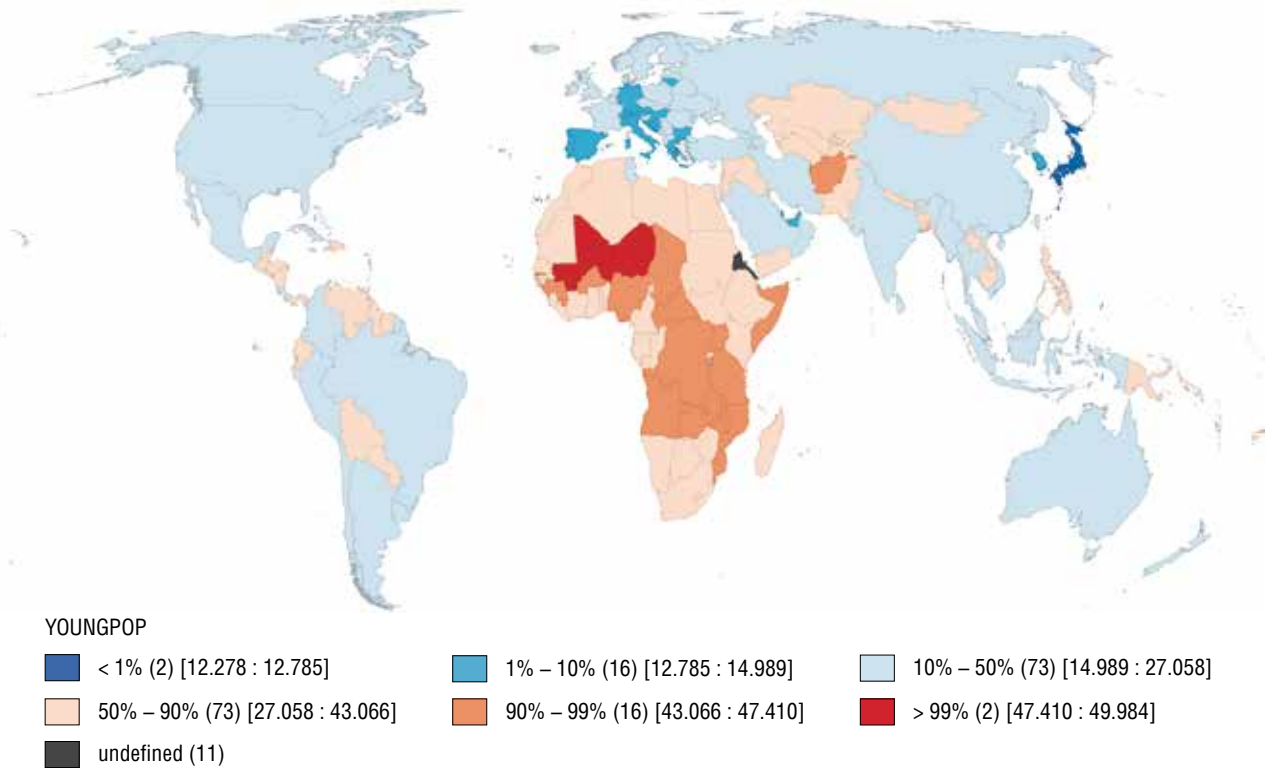


Fig. 2.6.1. Percentile cartogram for the “Young population” parameter

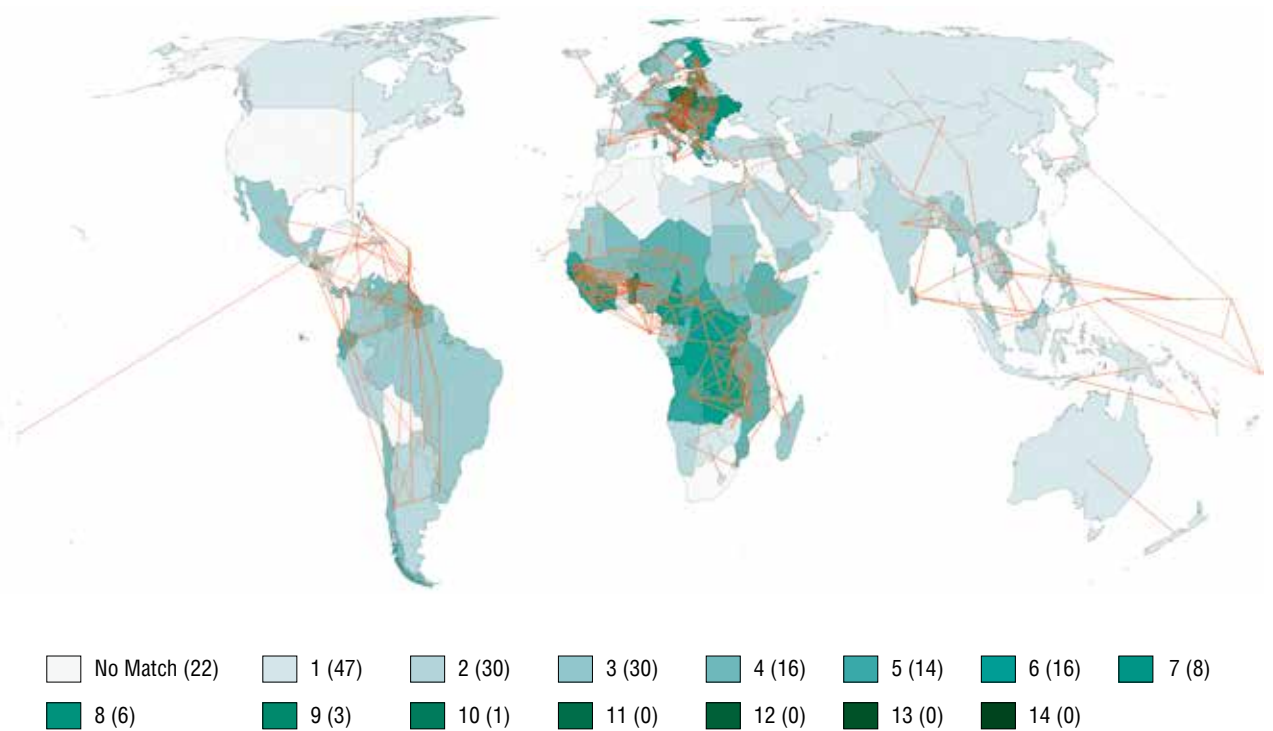


Fig. 2.6.2. Likelihood-ratio test for the “Young population” parameter

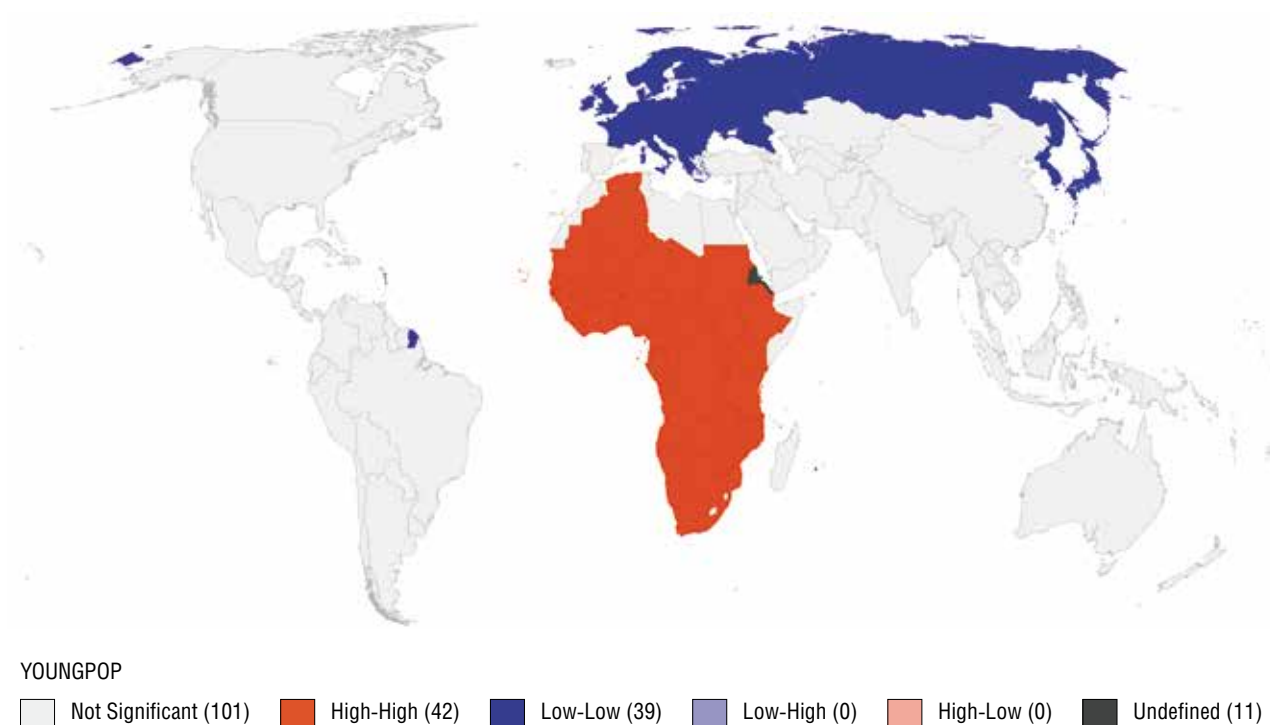


Fig. 2.6.3. “Young population” spatial autocorrelation cartogram for the geometric neighbourhood matrix

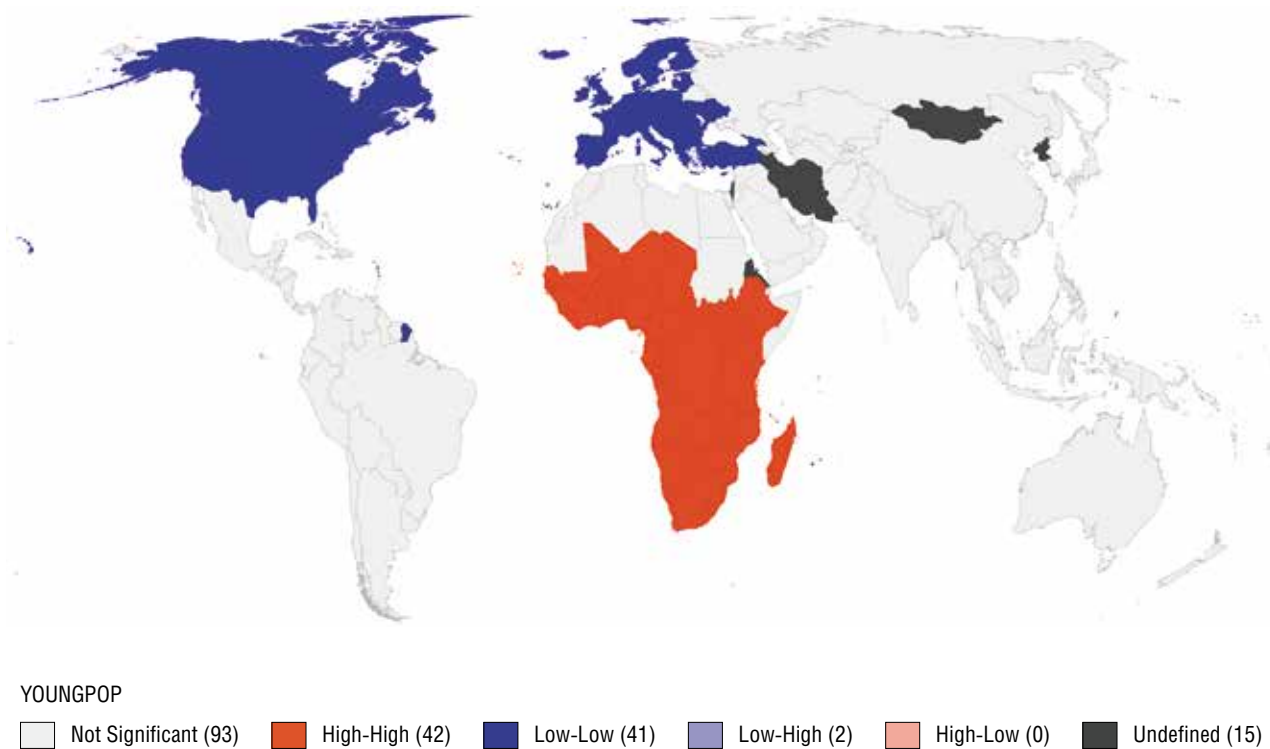


Fig. 2.6.4. “Young population” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.7. Elderly population

The “Elderly population” indicator is represented by the Elderly population dependency ratio, which measures dependents to working-age population ratio in different countries (the World Bank classifies the “elderly population” as people over 64). The indicator analysis demonstrates a sufficiently high positive spatial correlation.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.633	0.000	0.510	0.000
Geary's C	0.344	0.000	0.488	0.000

The percentile cartogram (Fig. 2.7.1) shows that countries with the highest indicator values are concentrated in Europe (although Japan is the leader here). The share of the elderly population is rather high on the American continent, in China and Australia, while it is minimal in Africa, some Persian Gulf states, and Afghanistan.

Therefore, the leaders for the indicator are mostly developed states that have a high life expectancy, low birth rates, high-quality healthcare and an active social policy. In some cases, a low share of the elderly population in the overall population structure can be explained by recent or ongoing armed and civil conflicts.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical neighbourhood matrix.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.7.3) features several large clusters. The first cluster (with high values) spans virtually all European states, including Russia. The second cluster with low values diagonally spans a large part of western, central and eastern parts of the continent. Another low-value cluster emerged on the Arabian Peninsula, where minimal indicator values are observed.

Global place	Country	Indicator
1	Japan	46.1709
2	Italy	35.5944
3	Finland	34.9579
Mean (65)	(North Korea)	13.3727 (13.2473)
Median (91–92)	(Malaysia, India)	9.4394 (9.6228; 9.2560)
180	Bahrain	3.0980
181	Qatar	1.6102
182	United Arab Emirates	1.2869

The geopolitical neighbourhood matrix cartogram (Fig. 2.7.4) features two spatial clusters, one of which is essentially a compound cluster. The first one, the Euro-Atlantic cluster, includes virtually all members of the bloc, with Turkey being a notable exception. This fact emphasizes this country's proximity to another geopolitical bloc — the Middle Eastern bloc. The latter, along with many African geopolitical alliances, forms a large African low-value cluster.

The geopolitical matrix clearly illustrates the North–South division. Here, Russia (as well as Belarus and Moldova) are no longer parts of the high-value cluster since they are members of another geopolitical bloc. At the same time, all African states are members of a low-value cluster, which emphasizes that members of various African integration alliances are homogenous when it comes to this particular indicator.

In both cases, no clusters emerge in other parts of the South Asian Association for Regional Cooperation (SAARC) and ASEAN+3 geopolitical blocs exhibit dispersion in this indicator's values, and given the overall low level of demographic burden, there are several countries with high levels of the elderly burden.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Elderly population” parameter (Fig. 2.7.2) reveals evident proximity between many European countries. Another visible node emerges in Latin America and the Caribbean. The cluster of neighbouring countries with similar ratios of elderly to working-age population emerges in West and Central Africa. At the same time, high indicator differentiation in Asia results in there being no significant connection nodes.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Ethnic minorities	0.073	0	−0.258	0.912
2	Linguistic diversity	0.202	0	−0.427	0.903
3	Economic inequality	0.183	0	−0.393	0.844
4	Maternal mortality	0.242	0	−0.442	0.807
5	Marriage	0.07	0	−0.237	0.802
6	Population growth	0.444	0	−0.594	0.795
7	Highly wealthy population	0.256	0	−0.446	0.777
8	Access to electricity	0.25	0	0.439	0.771
9	Particulate air pollution	0.384	0	−0.532	0.737
10	Cultural solidarity	0.152	0	0.334	0.734

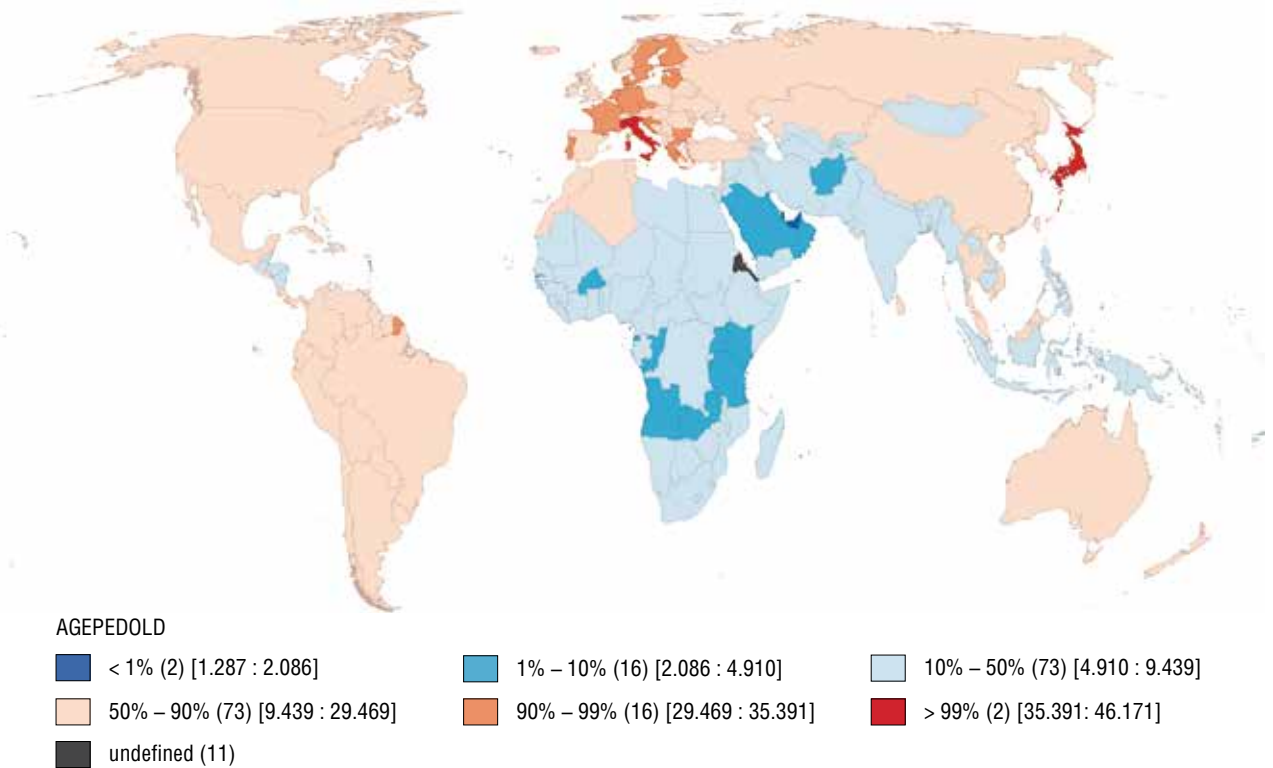


Fig. 2.7.1. Percentile cartogram for the “Elderly population ” indicator

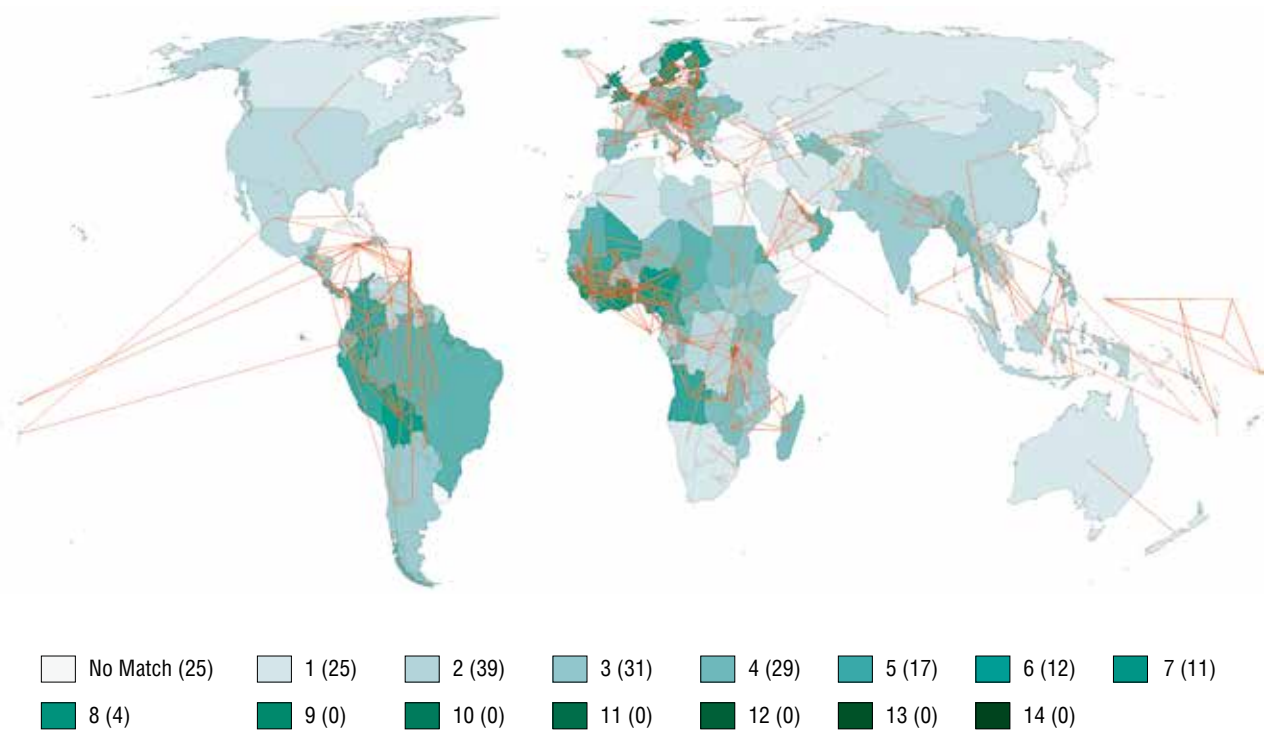


Fig. 2.7.2. Likelihood-ratio test for the “Elderly population” parameter

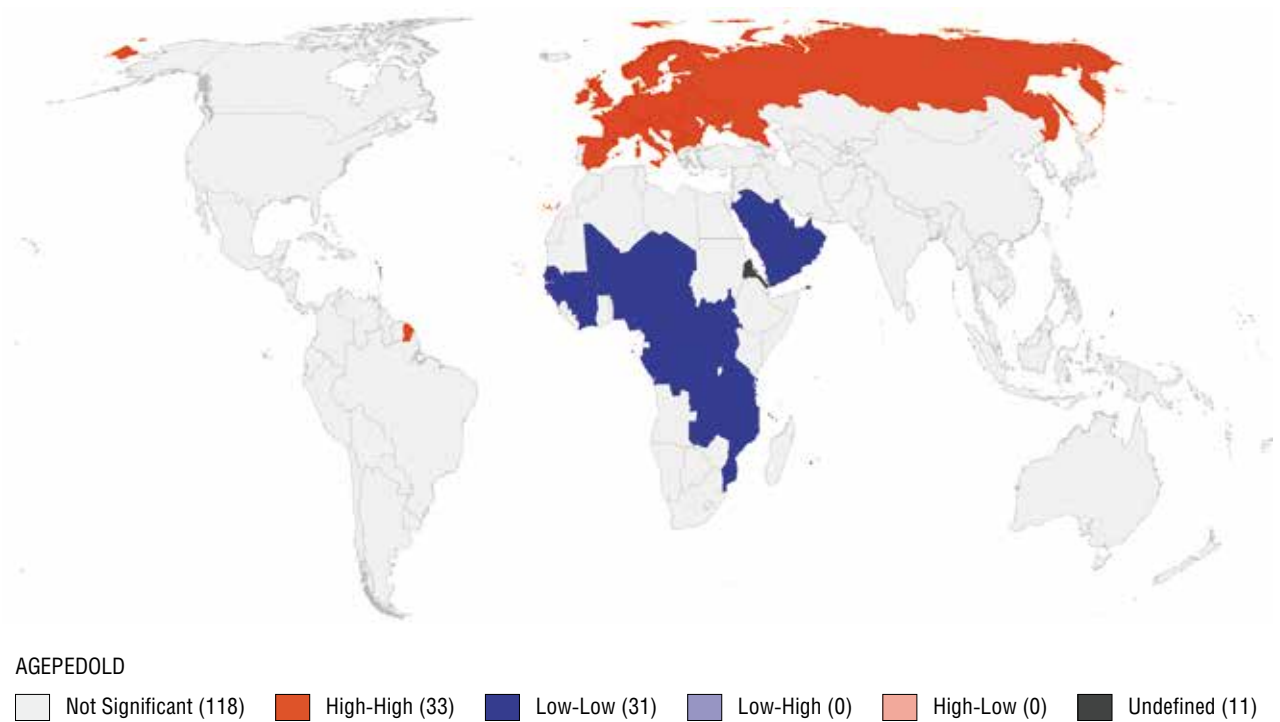


Fig. 2.7.3. “Elderly population” spatial autocorrelation cartogram for the geometric neighbourhood matrix

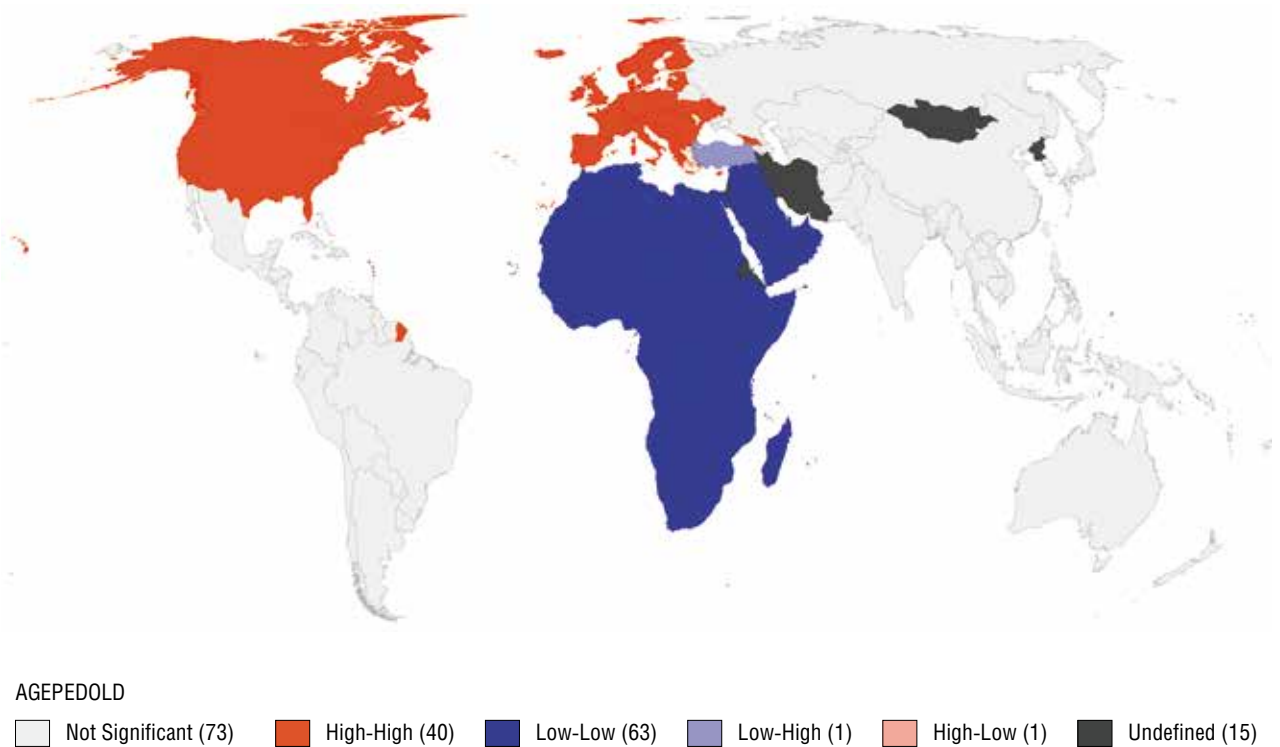


Fig. 2.7.4. “Elderly population” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.8. Female population

The “Female population” indicator measures the percentage of women in the total population.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.175	0.000	0.080	0.002
Geary's C	0.771	0.000	0.915	0.002

The percentile cartogram (Fig. 2.8.1) shows high indicator values in Eastern Europe, the European countries of the former Soviet Union (including Russia, Armenia and Georgia) and in El Salvador, Portugal, Guinea, Zimbabwe, Sri Lanka, and Myanmar. The maximum value was observed in Nepal.

Countries with low indicator values are situated mostly in Asia and Africa, Australia and Oceania. Minimal values for the “female population” indicator are recorded in some Persian Gulf states, where the structure of the population is largely determined by a high level of immigration.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and in this instance, the hypothesis that the world’s geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.8.3) shows the most visible high-value cluster in Eastern Europe (this cluster includes Russia), while a low-value cluster includes countries of the Arabian Peninsula, the Middle East and South Asia (with Nepal and Sri Lanka being the exceptions).

The geopolitical neighbourhood matrix cartogram (Fig. 2.8.4) shows several clusters with exceptions. Exceptions in the high-value Euro-Atlantic cluster include Norway, Albania and Luxembourg. Morocco, Mauritania, Tunisia, Sudan and Syria stand out as exceptions among LAS member states. Sri Lanka and Nepal differ from other members of SAARC. There are also differences with ASEAN. At the same time, there are no clusters at all in Africa, Latin and Central America.

Global place	Country	Indicator (%)
1	Nepal	54.5
2	Latvia	54.0
3	Lithuania	53.8
Median (92)	Slovenia	50.2566
Mean (129)	Guyana	49.8080
180	Oman	34.0
181	United Arab Emirates	30.6
182	Qatar	24.5

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Female population” parameter (Fig. 2.8.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram shows that such similarity exists between a group of Eastern European countries (where female population percentages are rather high) and in the Arab monarchies of the Gulf (where, on the contrary, the percentage of female population in the total population is low). On the whole, this indicator is characterized by great variance across the globe.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Forest areas	0.037463	0.009036	0.21	1.177
2	Conservation areas	0.026065	0.029455	0.17	1.109
3	Bioethical freedom	0.042003	0.010524	0.191	0.869
4	Regional trade relations	0.04173	0.005809	0.188	0.847
5	Institutional foundations of democracy	0.072027	0.000249	0.245	0.833
6	Petrol prices	0.085826	0.000141	0.263	0.806
7	Alcohol consumption	0.082949	8.44E-05	0.252	0.766
8	Renewable energy	0.041326	0.005916	0.173	0.724
9	Particulate air pollution	0.137568	1.49E-06	−0.307	0.685
10	Mobile subscribers	0.029148	0.026922	−0.138	0.653

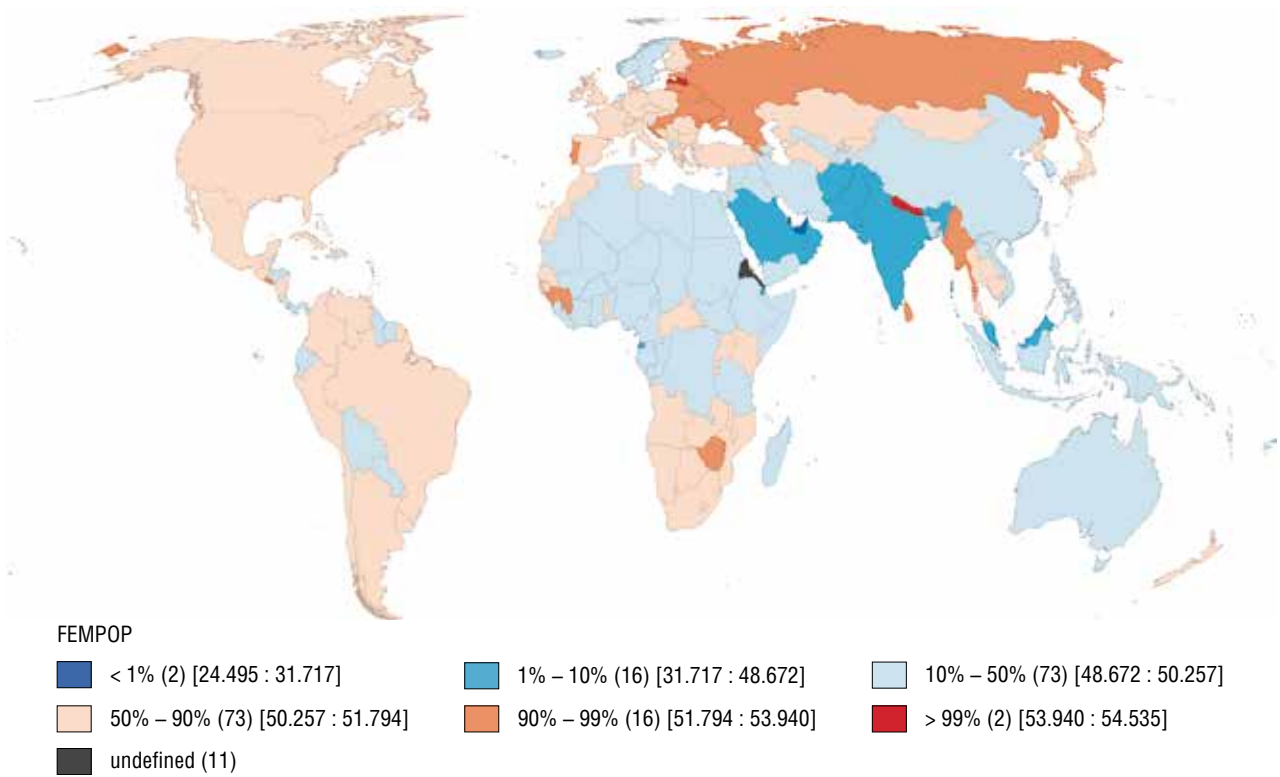


Fig. 2.8.1. Percentile cartogram for the “Female population” indicator

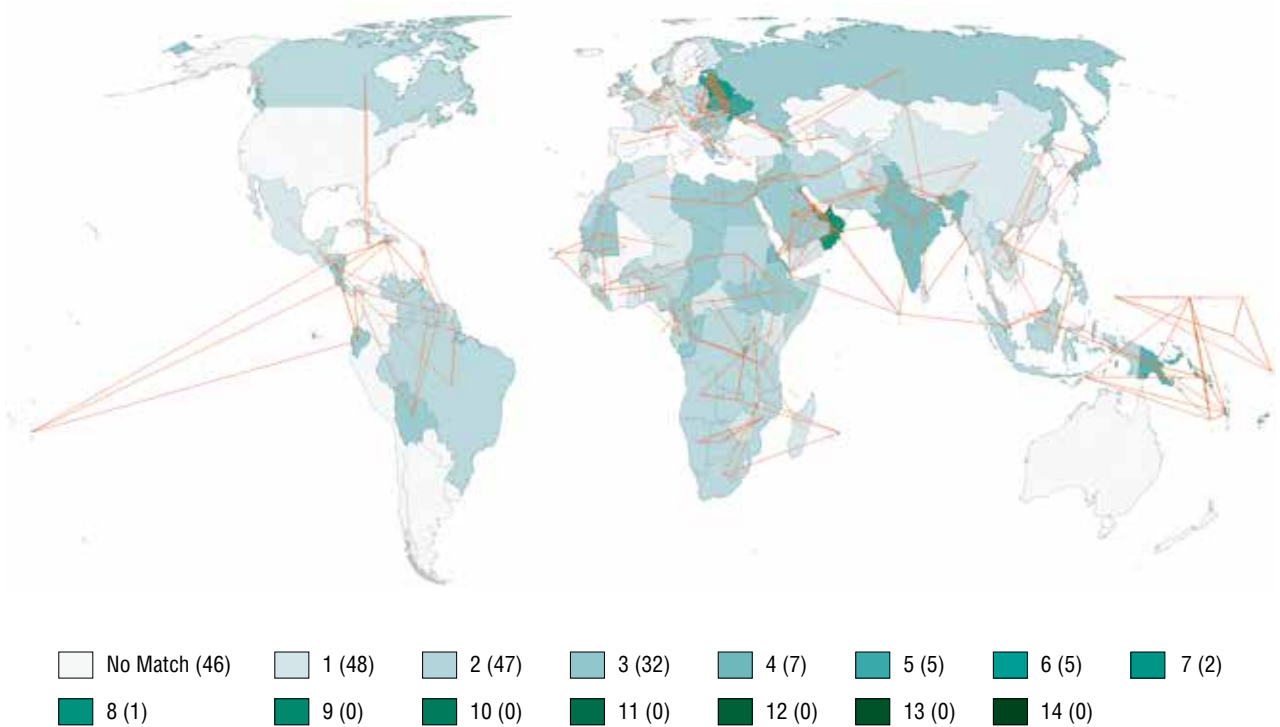


Fig. 2.8.2. Likelihood-ratio test for the “Female population” parameter

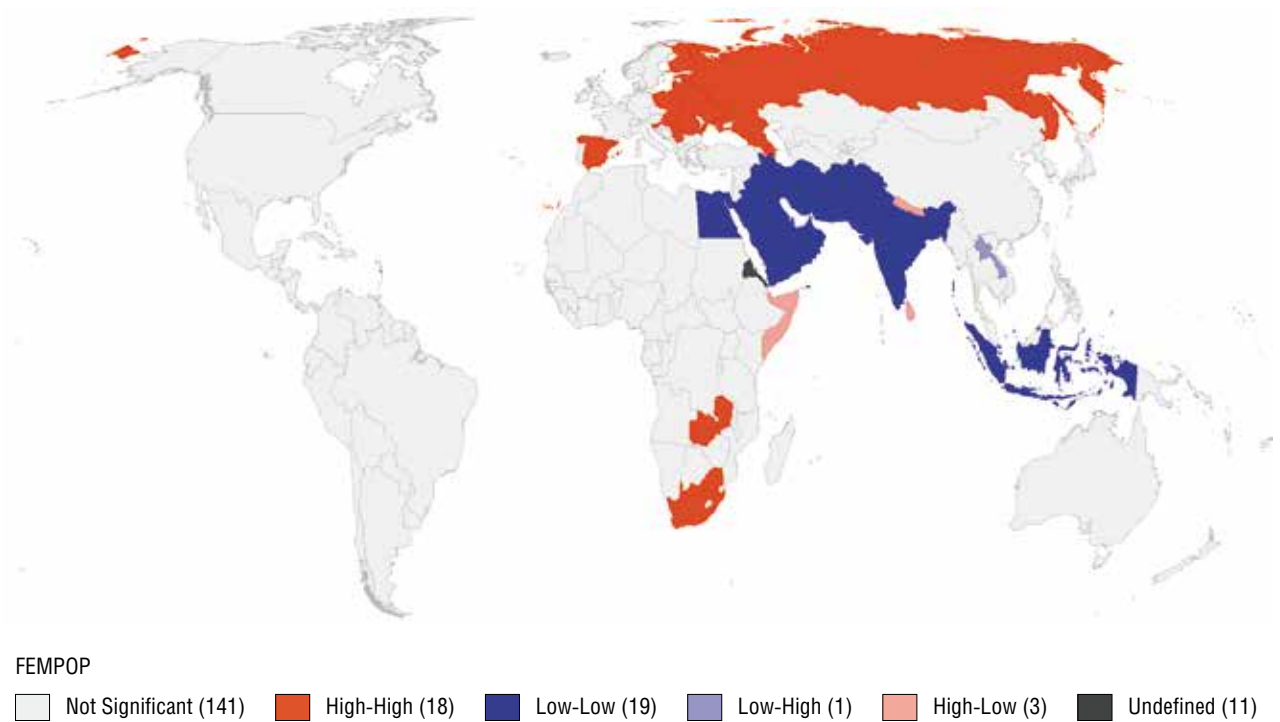


Fig. 2.8.3. “Female population” spatial autocorrelation cartogram for the geometric neighbourhood matrix

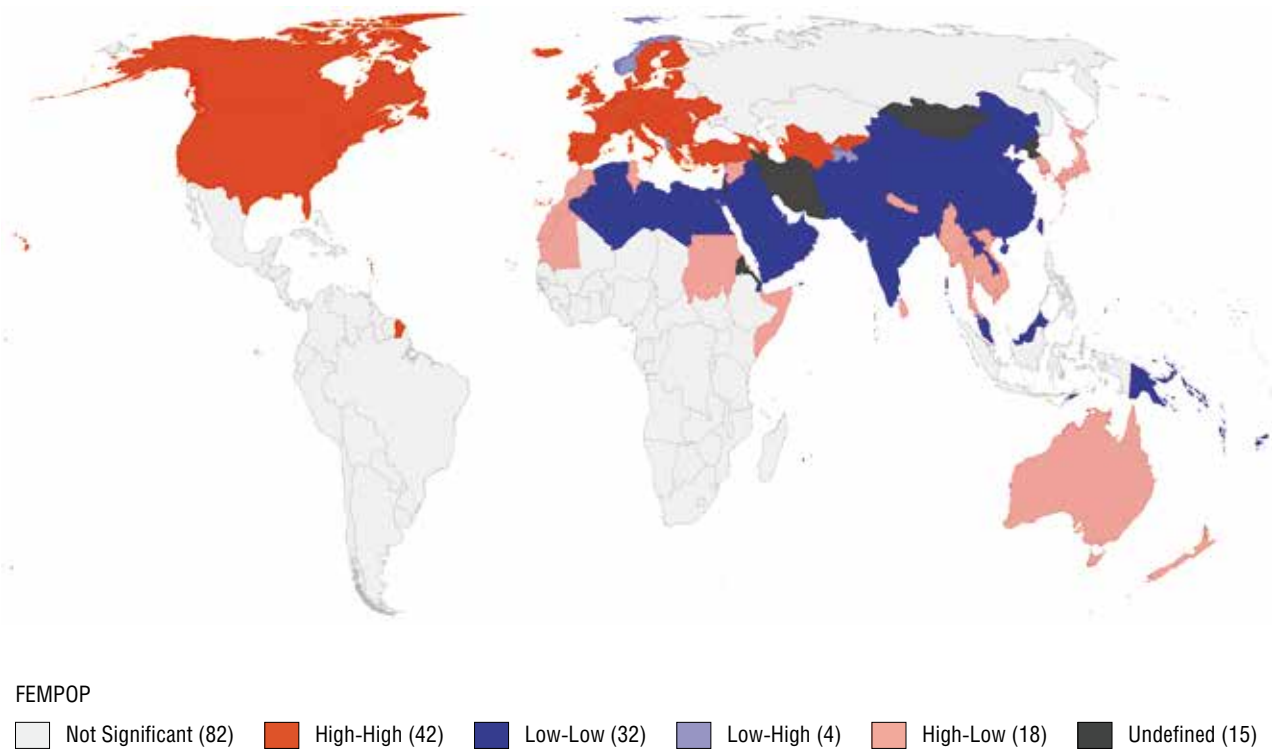


Fig. 2.8.4. “Female population” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.9. Marriage

The “Marriage” indicator is compiled using information about married women or women of reproductive age living in a marital union (15–49) given by experts at the UN Department of Economic and Social Affairs. According to the methodology used, “married” refers to women who are in a matrimonial alliance (defined in accordance with the laws on marriage or in accordance with customs of a given country) and to women in a union, i.e. to women living with a partner in a single family (other terms are concubinage, union based on mutual consent, an unmarried union or cohabitation). This section gives data for the year 2019.

	Geometry	P-value	Geopolitics	P-value
Moran's I	0.281	0.000	0.193	0.000
Geary's C	0.692	0.000	0.802	0.000

The percentile cartogram (Fig. 2.9.1) shows that states with the highest indicator values are mostly located in Asia and in some states in East, Central and West Africa, with the maximum values observed in Bangladesh, Mali, and Niger. Countries with the lowest indicator values are in the south of Africa and in the Caribbean. Relatively low marriage indicator values are typical for most countries of Europe and America. The mean is close to the median, which attests to the absence of significant statistical outliers. The median is recorded in countries located in three entirely different regions.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix shows two visible high-value clusters. The first includes a large number of Central, Southwest and Southeast Asian countries, and also China. In this region, women have limited educational and employment opportunities and often marry young. Two exceptions are Oman and Thailand, where indicator values are close to the median.

Global place	Country	Indicator (%)
1	Niger	83.7
2	Bangladesh	80.8
3	Mali	80.2
Mean (85)	(New Zealand)	57.7049 (57.7)
Median (91–93)	Zambia Switzerland Argentina	57.3
181	Grenada	34.9
182	Namibia	32.2
183	Jamaica	31.8

The second cluster is formed by countries of East and partially Central Africa, where high marriage figures for women stem from the high numbers of child marriages and polygamous unions. A low-value cluster emerges in the south of Africa (South Africa and Namibia). The exception in that region is Zimbabwe, which has a relatively high percentage of married women.

The geopolitical neighbourhood matrix cartogram shows several spatial clusters. One cluster with a low percentage of married women is the Euro-Atlantic cluster. There are exceptions in the south and east of this bloc: Ukraine, Poland, some Balkan states (Bosnia and Herzegovina, North Macedonia, Albania, Bulgaria), and also Georgia and Turkey. The similarity of these countries is explained by the importance of religion in everyday life, which is conducive to marriages. The cluster that includes Russia is generally a high-value cluster, but Russia itself is an exception there since it is statistically close to Euro-Atlantic bloc.

Another cluster where high values are observed (namely, West Africa) is heterogeneous: countries that are exceptions form a sub-cluster of sorts within it. Other geopolitical alliances in Africa are even more heterogeneous, which means that there no other clusters emerge there. The cluster of SAARC bloc member states appears to be the most monolithic, as they all have a high percentage of married women.

At the same time, the differentiation of indicator values in Latin America does not allow for the emergence of a cluster in any of the two matrices.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Marriage” parameter (Fig. 2.9.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram shows a similarity between South Asian countries. A node of connections is also emerging in Europe. At the same time, there is virtually no similarity in indicator values among neighbouring countries in the Middle East.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Agriculture	0.039481	0.008	0.244	1.508
2	Linguistic diversity	0.092673	0	0.273	0.804
3	Women in politics	0.045738	0.004	-0.185	0.748
4	Number of doctors	0.0417	0.006	-0.158	0.599
5	Rate of gross accumulation	0.028031	0.029	0.128	0.584
6	Elderly population	0.070175	0	-0.193	0.531
7	Cultural solidarity	0.059	0.001	-0.176	0.525
8	Passport power	0.141109	0	-0.268	0.509
9	Healthcare spending	0.07332	0	-0.192	0.503
10	Regional trade relations	0.044897	0.004	-0.148	0.488

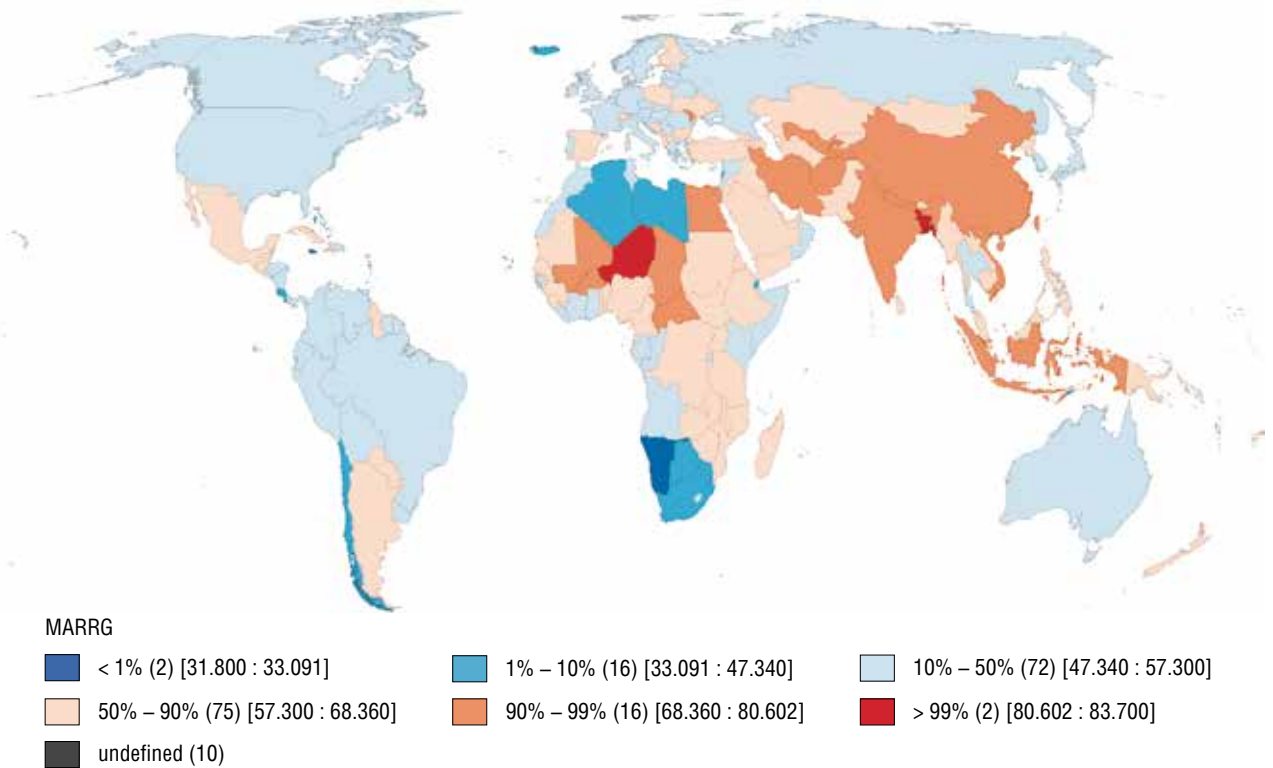


Fig. 2.9.1. Percentile cartogram for the “Marriage” indicator

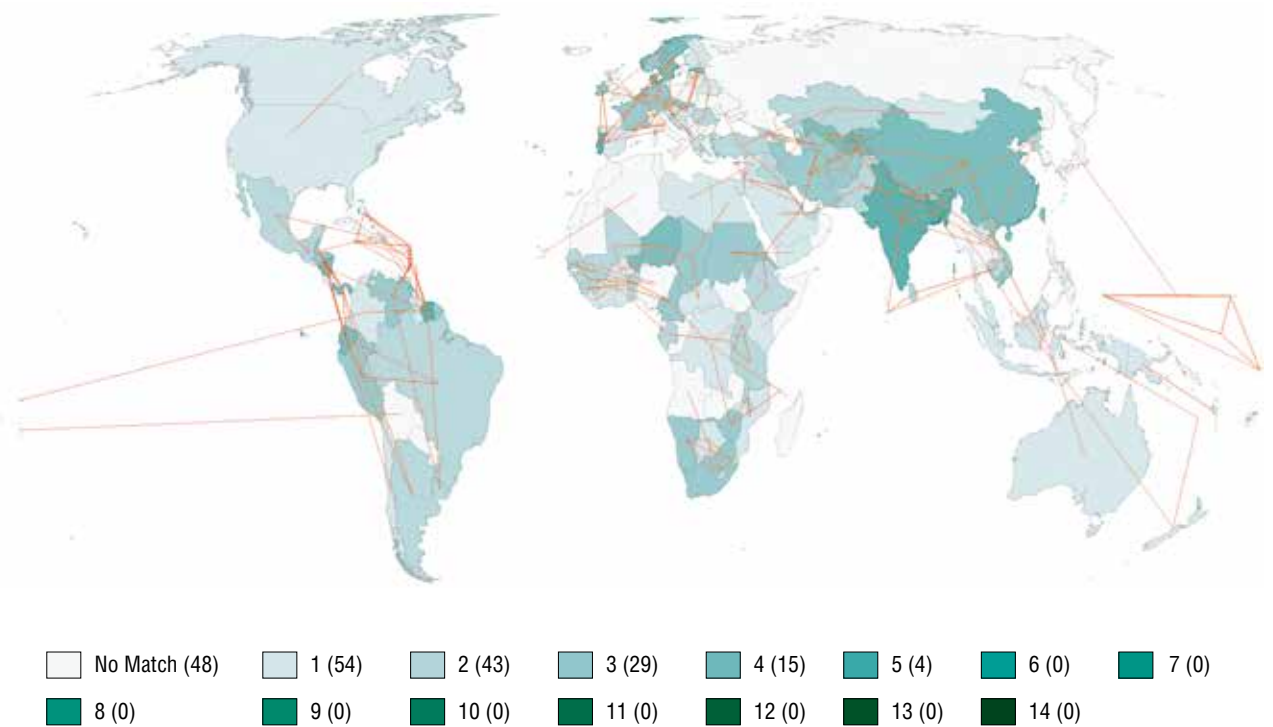


Fig. 2.9.2. Likelihood-ratio test for the “Marriage” parameter

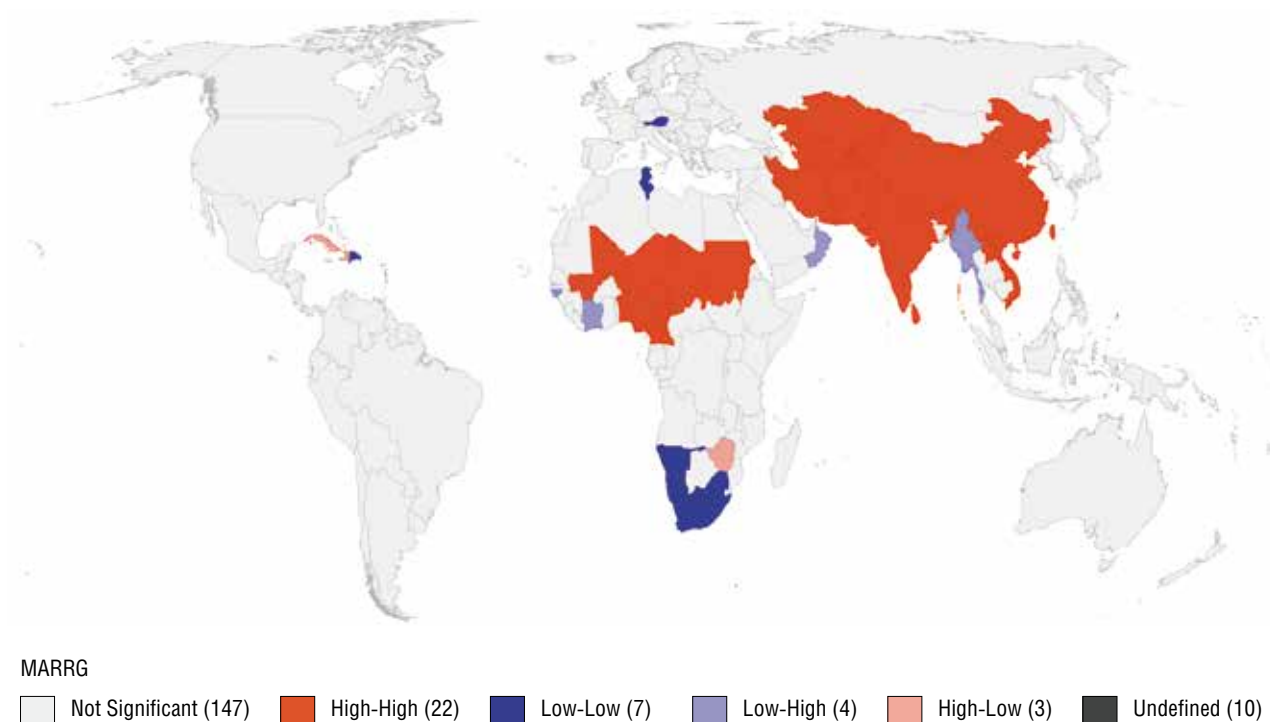


Fig. 2.9.3. “Marriage” spatial autocorrelation cartogram for the geometric neighbourhood matrix

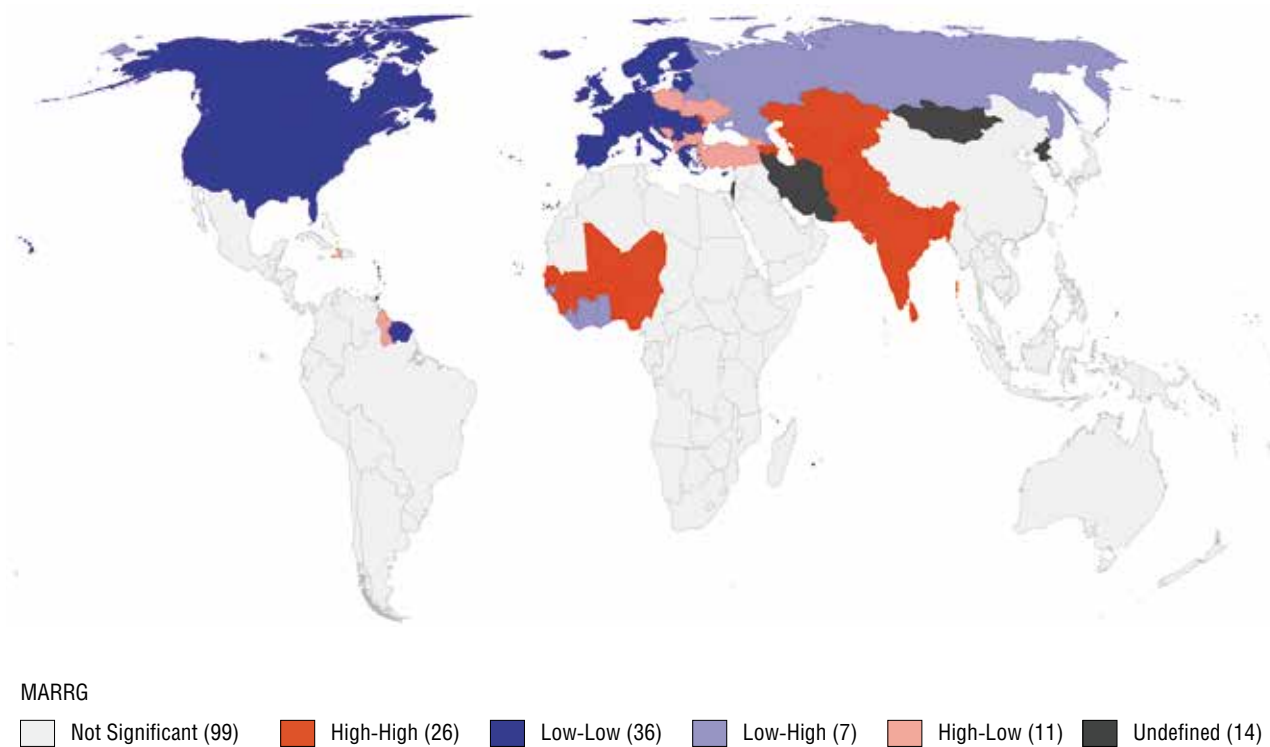


Fig. 2.9.4. “Marriage” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.10. Refugees

The “Refugees” indicator measures the number of refugees by country or territory of asylum as calculated by the World Bank using data from the Office of the UN High Commissioner for Refugees and the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA).

	Geometry	P-value	Geopolitics	P-value
Moran's I	0.156	0.000	0.060	0.008
Geary's C	0.962	0.365	0.935	0.008

The percentile cartogram (Fig. 2.10.1) shows that the largest numbers of refugees are in Turkey, Jordan, Iran, Pakistan and Bangladesh, as well as in the countries of Central and East Africa bordering on the Central African Republic and South Sudan, and in Germany and France. These countries form three principal global magnets for those seeking asylum. In most cases, these countries are the closest safe territory for refugees from neighbouring states. The number of refugees in a particular country often indicates a military or civil conflict in neighbouring states. In the case of European countries, the choice may be deliberate: refugees want to enter countries states that offer the most comfortable conditions for asylum-seekers.

At the same time, minimum indicator values are typical for countries that are geographically distant from conflict zones, which makes them less attractive for refugees. Another important reason for low numbers of refugees is the asylum policies of a given state. The mean is several times higher than the median, which may be explained by several significant maximum outliers.

The geometric neighbourhood matrix yields a greater higher spatial correlation than the geopolitical one, but generally, the spatial correlation is insignificant.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 2.10.3) shows several clusters. A high-value cluster emerges in the east of Africa. Its location illustrates the consequences of the many civil conflicts in that region. Logical exceptions among countries with high numbers of refugees are

Global place	Country	Indicator (persons)
1	Turkey	3,681,688
2	Jordan	2,957,877
3	Lebanon	1,424,728
Mean (28)	(Rwanda)	146,814.1491 (145,359)
Median (81)	Morocco	5,932
155	Bahamas	14
156–157	Uzbekistan, Jamaica	13
158–161	Haiti, Mongolia, Samoa, Saint Kitts and Nevis	5

Libya, Rwanda, the Central African Republic, and Eritrea, i.e. countries in crisis from which citizens have been fleeing and continue to flee.

The situation in the Middle East is highly heterogeneous. Given the extremely high absolute numbers of refugees in the region, Jordan, Iraq and Syria (Syria neighbours on the absolute leaders) form a high-value cluster. Israel is a predictable exception, while Saudi Arabia and some Gulf states that receive few refugees form a low-value cluster. Another low-value cluster is formed by countries of the Caribbean, which take in the fewest registered refugees. One stark exception in Europe is Switzerland, where the number of refugees is small compared to its neighbours. A similar situation is observed in Armenia and Afghanistan in Asia. India and its neighbours take in high numbers, making India an exception in South Asia in this respect.

The geopolitical neighbourhood matrix cartogram also shows a high-value cluster in Africa, which is made up members of the East African Community (with the exception of Burundi). The refugee indicator values in other African integration blocs are heterogeneous, and no clusters emerge. The Caribbean countries traditionally demonstrate low values for the refugee indicator and thus form a cluster of members of the Central American Integration System. A Eurasian cluster of low values comprising only Russia, Armenia, Azerbaijan and Tajikistan is not fully formed.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Refugees” parameter (Fig. 2.10.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram shows close proximity between the Caribbean countries and the shaping of a certain node of connections in East Africa. The high differentiation of the indicator in other regions results in there being virtually no visible connections.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Conflictogenity	0.064456	0.001	0.218	0.737311
2	Forest areas	0.03676	0.015	-0.164	0.731658
3	Passport power	0.028913	0.031	-0.145	0.727171
4	Institutional foundations of democracy	0.041475	0.010	-0.139	0.465847
5	Alcohol consumption	0.031273	0.026	-0.118	0.445236
6	Female labour	0.070871	0	-0.167	0.393518
7	Mobile subscribers	0.037389	0.019	-0.108	0.311967
8	Primary education enrolment	0.034347	0.022	-0.081	0.191022
9	Cultural exports	0.07154	0.003	0.017	0.00404
10	Budget deficit	0.083438	0.003	0.006	0.000431

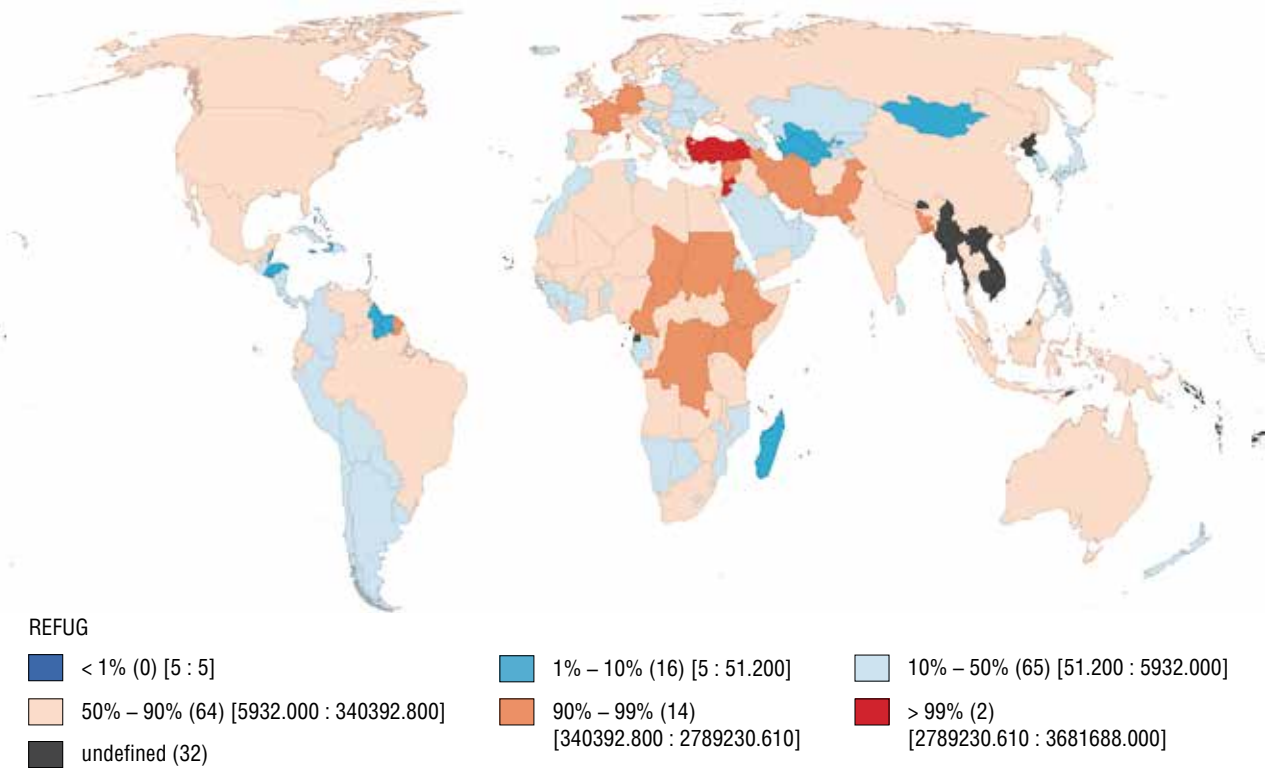


Fig. 2.10.1. Percentile cartogram for the “Refugees” indicator

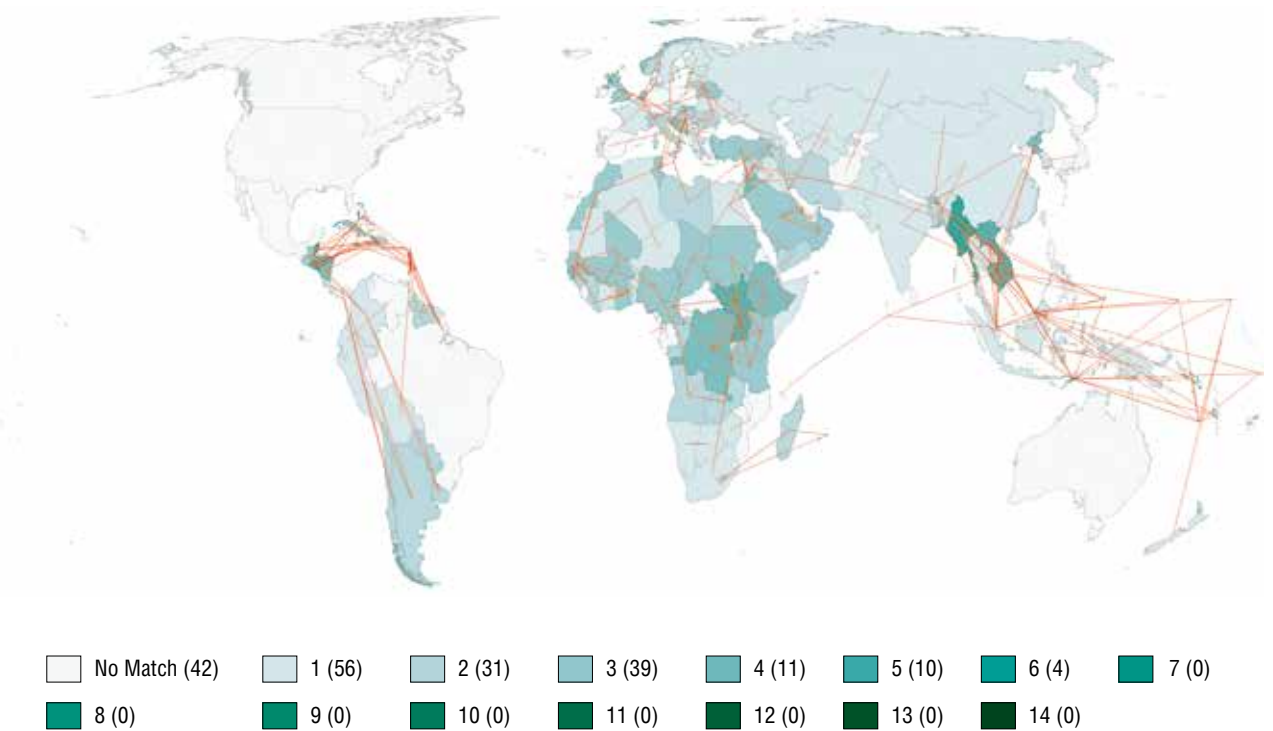


Fig. 2.10.2. Likelihood-ratio test for the “Refugees” parameter

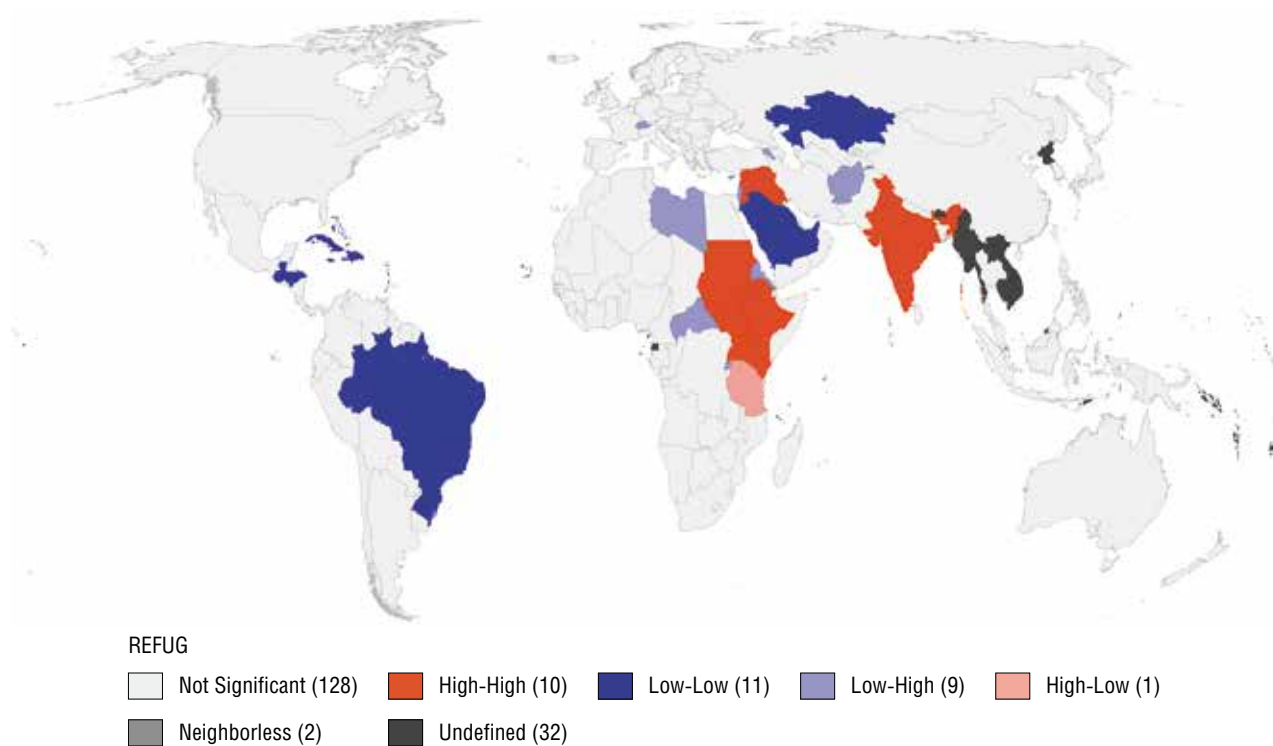


Fig. 2.10.3. “Refugees” spatial autocorrelation cartogram for the geometric neighbourhood matrix

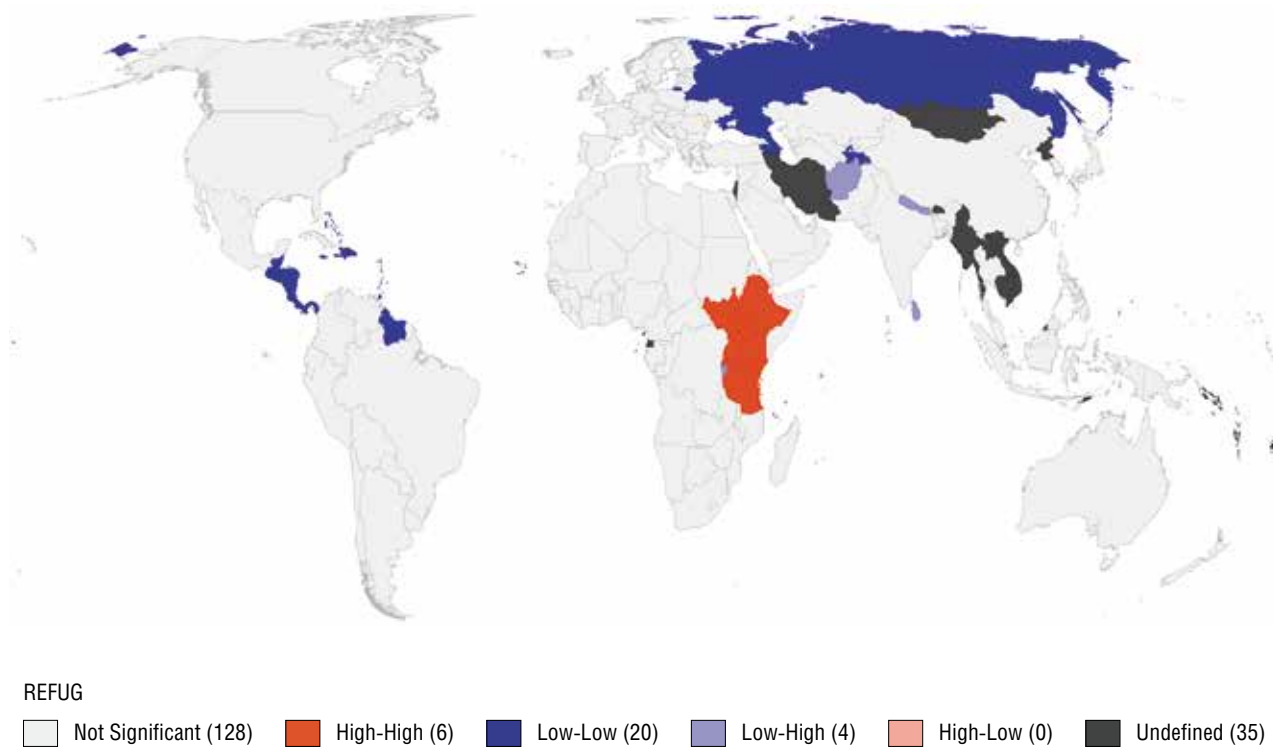


Fig. 2.10.4. “Refugees” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

2.11. Multifactor analysis of the “Demographics” section indicators

The research team analysed all ten indicators in the section in order to obtain a complete picture of the impact of the spatial effect on demographics.

The “Demographics” section indicators demonstrate significant geographic average divergence between the elderly population dependency ratio, the number of refugees broken down by country of asylum, and annual population growth.

The geographic average of annual population growth is skewed southward compared to the same point for the other two indicators because of this indicator’s higher values in the developing countries of Asia and Africa. The geographic average of the elderly population dependency ratio and numbers of refugees by country of asylum is skewed northward compared to the annual population growth because of this indicator’s far higher values in the north. The elderly population dependency ratio is far higher in the developed countries of Europe and North America, and also in Japan. The countries that receive the highest numbers of refugees are also mostly located in the Northern Hemisphere. However, the geographic average of the elderly population dependency ratio is skewed far more westward than that of the refugee indicator by country of asylum since the elderly population demographic burden is higher in the states of the West. The geographic average of the number of refugees is skewed eastward, which might be explained by Turkey and Jordan being the countries with the highest numbers of refugees and by the influence of the 2015 European migration crisis, when many refugees from North Africa and the Middle East arrived in EU countries. The ellipse of refugee numbers by country of asylum is far less stretched horizontally than other indicators, which is likely because of this indicator’s uneven global distribution.

When considered by geopolitical group, geographic average ellipses demonstrate significant divergence between the spatial distribution of urban population and population density. In the Euro-Atlantic bloc, both ellipses are significantly skewed eastward, into Europe, since both urbanization and population density are far higher there than in Canada and the United States. The ellipses differ in terms of shape and coverage. In the post-Soviet group of states, the urbanization ellipse is stretched northward compared to population density, although they almost coincide in the south. This is because the percentage of urban population is higher in Russia. The geographic average ellipse for urban population in the ASEAN+ bloc is also skewed northward, as it is influenced by indicator values for Japan, South Korea and China. In the Middle East and North Africa, the urbanization ellipse is significantly stretched southward and westward, while it coincides with the density ellipse in the northeast. As for other blocs on the African continent, urban population and density percentages for most of them have similar shapes and locations. One exception is the south of Africa, where the population density ellipse is skewed eastward because of the high values observed in the case of Mauritius.

Multifactor Geary’s C helps identify groups of neighbouring countries on spatial autocorrelation cartograms that are most similar and most dissimilar to their neighbours in the ten indicators of the demographic section.

The geometric neighbourhood matrix (Fig. 2.11.1) reveals a high degree of similarity between the indicators of South American countries and most sub-Saharan states. The largest compound cluster is formed by European countries and Russia, and also by Central Asian states, Afghanistan, Pakistan, India and China. However, when the p-value changes to 0.01, clustering in Asia does not happen. Clusters of countries that are unlike their neighbours do not emerge when the geometric neighbourhood matrix is applied.

The geopolitical neighbourhood cluster (Fig. 2.11.2) yields a slightly different picture. A cluster of countries with differing demographic indicators emerges in the north of Africa among Arab League member states. These countries do, indeed, exhibit major differences in such indicators as female population or numbers of refugees. The cluster of similar countries in the rest of Africa no longer includes South Africa.

The cluster of similarities in South America remains. Another cluster of similarities is formed by the countries of the Caribbean. In the geopolitical neighbourhood matrix, the Euro-Atlantic cluster of countries similar to their neighbours now includes Canada. Russia does not form a cluster with its geopolitical neighbours, while Central Asian countries (with the exception of Tajikistan) do make a cluster of similarities. Notably, similarity clusters do not emerge in Asia's geopolitical blocs (SAARC/ASEAN+3).

To identify exception countries, i.e. countries with maximum differences from their surroundings in all ten indicators in the "Demographics" section, the research team used the inverse spatial cluster analysis method. The cartogram for cluster analysis uncontrolled for geographic proximity (Fig. 2.11.3) only identifies individual groups of neighbouring countries with similar median values of demographic indicators.

Europe now has a cluster that includes most countries in Western (including the United Kingdom) and Southern Europe, and also Finland, the Baltic states, the Czech Republic and Hungary. Therefore, Central and Eastern European countries and the European countries of the former Soviet Union exhibit a two-pronged demographic trend: part of them forms a cluster with values similar to those in Western Europe, while the other part (including Ukraine and Belarus) forms a cluster with Russia and China. At the same time, the median of demographic indicators for Norway, Sweden, Iceland and Ireland places them in a different cluster that also includes Canada and the United States.

Asia demonstrates a great diversity of median demographic values. A cluster emerges only on the Arabian Peninsula (with the exception of Yemen) and a small cluster is emerging in South Asia (India, Nepal, Bangladesh, Bhutan). Japan's demographic indicator values lean toward the European cluster.

With few exceptions, Africa breaks down into four parts: a cluster of North African states (with the exception of Egypt), a cluster in the east, a cluster in the south that has heterogeneous demographic indicators, and a territory with similar demographics that includes countries of West and Central Africa.

The countries of the Caribbean and Central America demonstrate variety, but a cluster is forming in South America that includes such countries as Brazil, Argentina, Colombia and Venezuela.

Far clearer clusters emerge on the second cartogram, where the geographic factor is assigned the same value as the sum of all other indicators (Fig. 2.11.4). Europe breaks down into two parts: a western part that leans towards the United States and Canada, and an eastern part that includes Central and Eastern European countries (with the exception of the Czech Republic), the Balkan states, Southern Europe (with the exception of Spain, which belongs to the western part), Russia, Georgia and Armenia.

The geographic factor reduces diversity in Asia. The countries of Central Asia and the Middle East form a cluster with most Middle Eastern countries. However, Turkey, Lebanon, Israel and Cyprus fall in the same category as the countries of North Africa. Yemen still stands apart from Arab countries. In other regions, China, Japan, both Koreas and Thailand make the same cluster, while other Southeast Asian states are divided between a continental cluster that includes India, and an island cluster that includes Australia and New Zealand.

Integral clusters emerge in other regions. African clusters largely repeat the clusters built solely on geographic proximity: for instance, an identical composition of clusters in the south of Africa. Morocco is an exception in West Africa, as it is close to the Arab countries of the north. Similarly, the geographic and combined clusters coincide in the south of Latin America. However, Mexico, Venezuela, Guyana, Suriname, Colombia, Ecuador, and the countries of Central America and the Caribbean turn out to be in same cluster in this case.

The value scatter plot representing the results of multidimensional scaling of demographic indicators (Fig. 2.11.5) emphasizes that most states form an oval cloud located diagonally in the first and fourth quadrants. The most significant exceptions are to be found in the second quadrant. This is Monaco (which is likely because of the extremely high population density value in this microstate). Far removed from others is an agglomeration of small states from three regions: European microstates, the Caribbean, and Oceania (Saint Kitts and Nevis, Tuvalu, Dominica, the Marshall Islands, Palau, Andorra, San Marino, Nauru). Somewhat removed from the main cloud in the bottom part of the chart, we find Liechtenstein and Eritrea (which may



Fig. 2.11.1. “Demographics” section spatial autocorrelation cartogram for the geometric neighbourhood matrix



Fig. 2.11.2. “Demographics” section spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

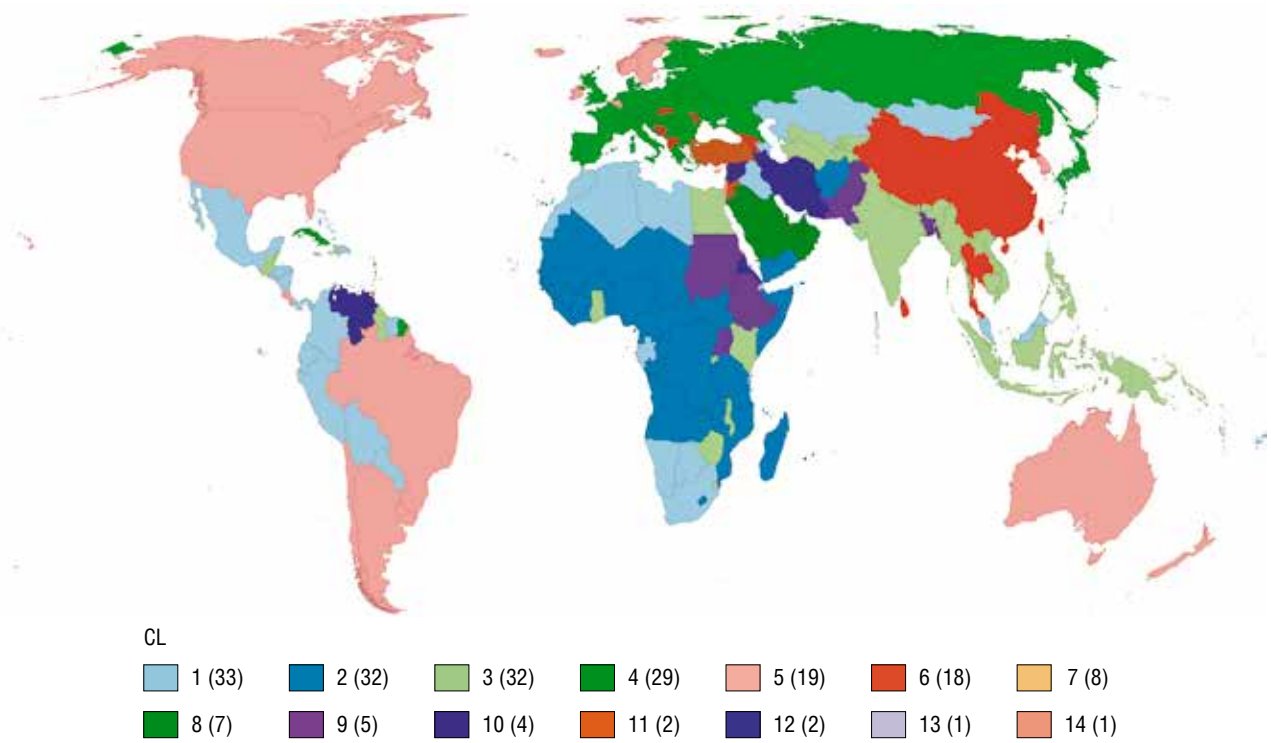


Fig. 2.11.3. Statistical clusters cartogram for the "Demographics" section indicators

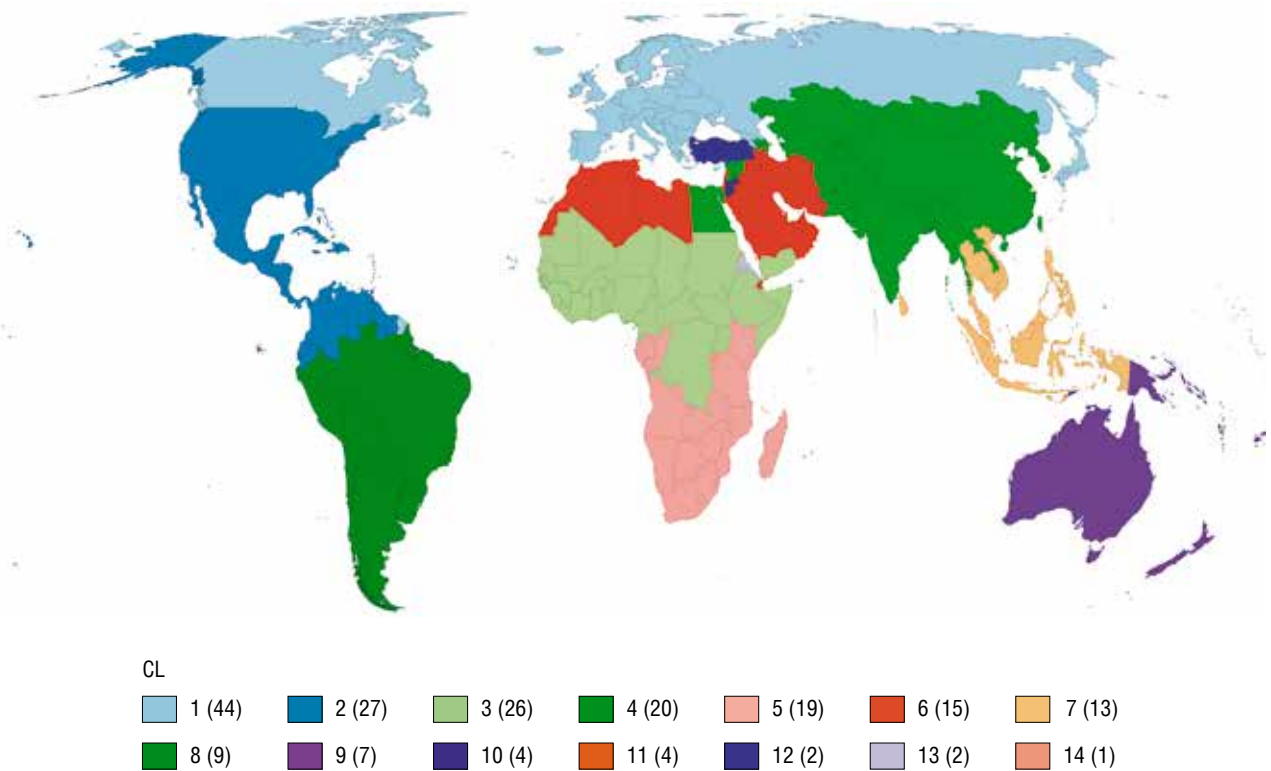
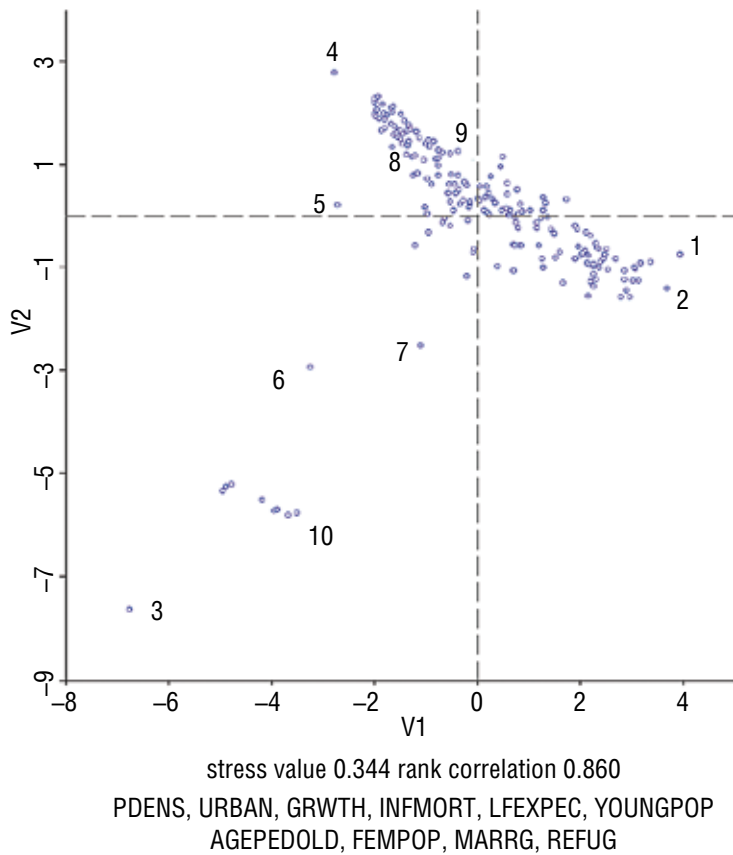


Fig. 2.11.4. Statistical clusters cartogram for the "Demographics" section indicators controlled for geographic proximity



1	Niger
2	Chad
3	Monaco
4	Japan
5	Singapore
6	Liechtenstein
7	Eritrea
8	Russia, US
9	China
10	Saint Kitts and Nevis, Tuvalu, Dominica, Marshall Islands, Palau, Andorra, San Marino, Nauru

Fig. 2.11.5. Multidimensional scaling chart for the “Demographics” section indicators

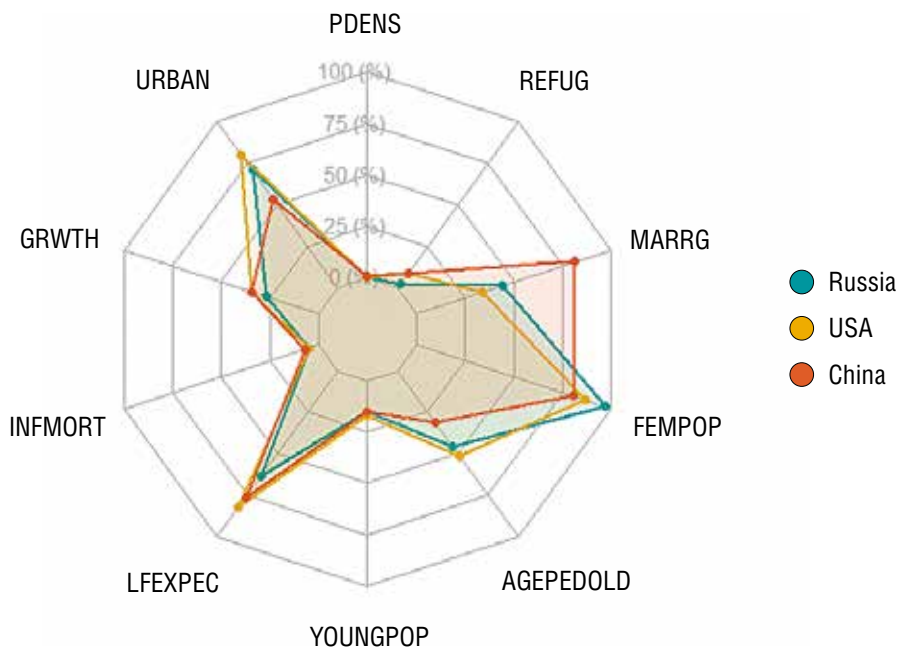


Fig. 2.11.6. Radar chart for the “Demographics” section indicators

be due to the lack of data for some of the section's indicators). Nigeria and Chad stand apart from other states (because of the ratio of young people and population growth), and Japan stands apart in the opposite quadrant (with the highest ratio of elderly people). Russia and the United States are closer to the centre of the scatter plot and sit virtually next to each other. China is slightly above them, but still within the cloud.

2.12. Spatial factor for the “Demographics” section indicators

An analysis of the section's indicators leads to the conclusion that the spatial factor is significant for demographics. Several demographic indicators show high values for Moran's I and are among the ten highest indicators in the Atlas for both the geometric and geopolitical neighbourhood matrices. This list includes infant mortality (Moran's I of 0.696 and 0.571, respectively), elderly population ratio (0.633 and 0.510) and young population ratio (0.595 and 0.539, respectively). Additionally, significant spatial autocorrelation (greater than 0.5 for the geometric matrix) is observed for population growth (0.574 and 394). Therefore, we may claim that spatial autocorrelation characterizes demographic phenomena related to changes in population size and the ratios of different age groups. This means that changes population reproduction are correlated among neighbouring countries. Additionally, a relatively high Moran's I is typical for the urban population (0.435 and 0.352), which is logical given the importance of urbanization for birth and mortality rates.

At the same time, the findings of this section's demographic indicator analysis do not confirm the hypothesis that geopolitical neighbourhood is of greater importance since Moran's I is always lower for the geopolitical matrix. Individual indicator analysis shows that the countries of South America, Africa (with the exception of the countries in the north of the continent) and South and Southeast Asia have similar demographic indicators, yet are involved in different integration processes, while the countries of Europe, North America, the Middle East and North Africa, as members of the same integration alliances, manifest differences in demographic results. Particularly telling is the demographic split of sorts between European countries along a notional dividing line between Western and Eastern European countries.

The two-factor analysis of the spatial index shows that significant results of the spatial effect index are most frequently recorded when demographic indicators are analysed alongside indicators from the “Equality,” “Culture” and “Economy” sections. This confirms an interconnection between demographic, economic and social factors. In most cases, however, when the spatial effect index is > 1 , values for the coefficient of determination and two-factor Moran's I are low. Only results in the “Population growth — Maternal mortality” pairing appear indicative (SEI = 1.044, R-squared = 0.23, two-factor Moran's I = 0.49).

Multifactor analysis methods compellingly showed that demographic indicators clearly divide the world into the ageing North on the one hand, and the South with a rapidly growing young population, on the other.

Multidimensional scaling for ten indicators shows that most countries are densely located in the oval cloud, which stretches from the upper left to the lower right quadrant. Small states of three regions, namely, European microstates, the Caribbean and Oceania, account for the main outliers.

When using the geographically weighted regression method, the research team identified several models for the indicators included in the section and selected the most valid: the model with a regressive correlation between the percentage of children under 14 years in the total population (YOUNGPOP, a dependent variable), and a combination of five independent variables: natural population growth (GRWTH), female population percentage in the total population (FEMPOP), percentage of primary school dropouts (PRIM-DROUT), passport power (PASS) and the latitude of a state's capital (1LAT); for the latter two, the regressive correlation is inversed. The selected model has a rather high regression coefficient (greater than 0.8). The most predictable link between the percentage of children with such factors as female population and high natural growth is supplemented by a high percentage of primary school dropouts, with attendant phenomena being earlier marriages and a higher number of children. Inverse dependence with two out of the

Model selection criterion	Indicator	Value	Significance level
Normality of errors	JB p-value > 0,1	—	0.260901
Heteroskedasticity	K (BP) p-value < 0,05	—	0.00247
Multicollinearity	VIF < 7,5	1.655652	—
Spatial Autocorrelation	Moran's I p-value > 0,1	—	0.256468
Lagrange Multiplier – Geometry Weights	Lagrange Multiplier (lag)	28.1125	0.00000
	Robust LM (lag)	19.3167	0.00001
	Lagrange Multiplier (error)	8.9278	0.00281
	Robust LM (error)	0.1320	0.71637
Lagrange Multiplier – Geopolitics Weights	Lagrange Multiplier (lag)	12.2864	0.00046
	Robust LM (lag)	6.2030	0.01275
	Lagrange Multiplier (error)	13.0830	0.00030
	Robust LM (error)	6.9995	0.00815

	OLS	SAR geometry	SAR geopolitics
Constant	10.512802 (0.000000)	-4.00727 (0.40520)	-7.33007 (0.18140)
W_YOUNGPOP	—	0.31413 (0.00000)	0.178532 (0.00077)
1LAT	-0.081908 (0.000000)	-0.0430175 (0.00509)	-0.0558747 (0.00088)
GRWTH	3.209394 (0.000000)	2.39043 (0.00000)	3.02048 (0.00000)
FEMPOP	0.464358 (0.000000)	0.515422 (0.00000)	0.672205 (0.00000)
PASS	-0.094640 (0.000000)	-0.0651137 (0.00000)	-0.0768319 (0.00000)
PRIMDROUT	0.115508 (0.000001)	0.119373 (0.00000)	0.122809 (0.00000)
Heteroskedasticity (Breusch-Pagan test)	18.414357 (0.002470)	23.9951 (0.00022)	25.8585 (0.00010)
Normality of errors (Jarque-Bera test)	2.687229 (0.260901)	—	
Spatial dependence (Likelihood-ratio test)	—	28.2230 (0.00000)	11.1545 (0.0084)
Akaike information criterion	1127.92	840.66	857.729
Schwarz information criterion		861.873	878.942
R-squared	0.870126	0.886221	0.869387

model's indicators reflects a demographic trend of the more developed countries of the North that, as a rule, have higher passport power and demonstrate smaller percentages of children in the total population.

By using the Lagrange multiplier, the research team established that the spatial lag method is preferable when using geometric and geopolitical neighbourhood matrices. Lower values for the Akaike information criterion indicate that SAR spatial models are more valid than the non-spatial OLS model. At the same time, the Schwarz information criterion shows that when spatial models are compared, the geometric model is more valid and provides a better explanation for the dependent variable (R-squared in geometry $0.886 > 0.869$ R-squared in geopolitics).

The standard deviation cartogram shows that the selected model is the explanatory model for Russia, most countries of Europe, Africa, South America, and some Asian states. At the same time, it can not be applied at all to South Sudan, Somalia, Niger, Syria, Afghanistan, Guatemala Cuba, Eritrea, Sri Lanka, Nepal, North Korea and Thailand.

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3

Economy

GDP (PPP) per capital

Agriculture

Industry

Medium- and hi-tech industries

Rate of gross accumulation

Services sector

Imports

Exports

Unused export potential

Regional trade agreements

*Multifactor analysis of the “Economy”
section indicators*

*Spatial factor and “Economy”
section indicators*

ANALYSING the economy is key for assessing human development since it allows researchers to form a general picture of both the amount of resources available for improving the population's wellbeing and the most promising areas in the development of human potential.

Economic data offers broad scope for using various quantitative methods, including those for spatial analysis. However, researchers need to keep in mind that there are lives of real people behind abstract statistical calculations.

We should note that economics has only recently prioritized human potential development. Pakistani economist Mahbub ul Haq [1995, xvii], one of the authors of the human development index concept, wrote that as late as the middle of the last century, economics was dominated by the idea that the main purpose of national economic policies was to increase national revenues. The focus changed, however, and now most countries prioritize the expansion of human capabilities in various areas, not only the economy, but also politics and culture.

The ten indicators selected for this section characterize various aspects of the economy and provide a comprehensive foundation for comparing human development by country. Together with parameters from other sections, the data in this chapter represents the territorial assets of countries [Camagni 2010, 119] not only as a narrowly construed set of advantages for a particular type of investment, but also as more broadly interpreted conditions for developing human potential.

Notionally, the indicators selected may be divided into four sub-groups.

The first indicator, gross domestic product (by purchasing power parity) per capita, stands apart from all the other indicators and is the key basic parameter that allows researchers to assess economic development and compare states that differ significantly in the size of their area and population.

We should note that, for a long time, this indicator was the principal benchmark for comparing countries [El-Imam 2008, 154], yet from the very outset, supporters of a more comprehensive approach to human development, including the authors of the Human Development Index, have criticized excessive focus on this parameter.

Indeed, in and of itself, a given state's GDP, even calculated per capita, provides only an indirect idea of the level of prosperity of a given country as it does not reflect the levels of poverty and inequality in a given state, or the opportunities its population may enjoy in various areas. Moreover, excessive concentration on eco-

conomic growth has the unpleasant consequence of unfavourably affecting the environmental situation and, consequently, undermining people's prosperity and developmental stability [Rios-Osorio, Cruz-Barreiro & Welsh-Rodriguez 2014, 43].

However, as Frances Stewart, Gustav Rannis, and Emma Samman have noted (2018), this does not mean that the GDP indicator should be ignored entirely, since economic resources provide a fundamental means for human development. Moreover, in the long term, human development and economic growth indicators move in the same direction and support each other's development trends. Understanding and using this two-way connection bolsters government policies [Taori 2000, 9].

The second sub-group forms a picture of the manufacturing output of key economic sectors: agriculture (including forestry and fishery), industry (including construction) and services. In this case, we decided to use manufacturing volume without recalculation by per capita value or as a GDP ratio, so that we could identify correlations between different countries' economies expressed in real terms.

The third sub-group describes manufacturing through two parameters that are particularly important at the current stage of economic development. First is the percentage of medium- and hi-tech products in industrial manufacturing. Improving the technological level of a given country's industry allows the country to achieve more stable economic development, gain a more advantageous standing in international division of labour, and improve the qualifications of its labour force [Chen & Shih 2005]. Many countries, including Russia, have prioritized the production of state-of-the-art designs and the use of high technologies, and this parameter helps to assess progress in this matter.

Rate of gross accumulation is another indicator in this sub-group. This parameter shows how much countries invest into maintaining and increasing their core assets, i.e. into their future development. Rate of gross accumulation is inextricably connected with economic growth, and provided this matter is approached reasonably, it helps lay the foundations for countering poverty and inequality [McKinley 2006, 350].

The fourth group describes a given state's foreign economic activity. This is also important for developing human potential as it makes it possible to increase economic efficiency via international exchange. Import and export volumes show the geographic distribution of world trade.

As regards export, we need to understand that large volumes of exported goods per se do not ensure human development if we are talking production based on unqualified labour with little use of cutting-edge technologies. As Miguel Ceara Hatton and Rolando Reyes noted [1995, 45], merely building up exports without attempting to restructure manufacturing with a view of achieving a higher technological level may, on the contrary, result in greater poverty and inequality. Therefore, this section supplements information on export volumes with the percentage of medium- and hi-tech manufacturing sectors.

The purpose of this research is not only to analyse human potential in various aspects, but also to outline its development path. One indicator that helps us to do this is "unused export potential," as assessed by the International Trade Centre. The Atlas also contains data on the numbers of regional trade agreements in which countries are involved, which, again, helps assess the degree of international cooperation.

When we analyse the data provided, we need to remember their comprehensive effect. For instance, when agricultural productivity increases in developing countries, this stimulates human potential development, which, in turn, advances improvements of agricultural practices and further increase of agricultural productivity [Ghosh 2014, 31].

Generally, the indicators in this section demonstrate high alignment with the selection criteria: seven indicators meet six criteria, while three indicators meet five criteria.

We should note that a large number of economic indicators may be found in other sections of the Atlas: in full compliance with the main idea of the human development index, special attention is paid to demographics, as well as to the equality, education and healthcare indicators. Financial indicators are considered in a separate section. Thus, the research team may form a comprehensive picture of human development and a multifaceted foundation for analysis.

3.1. GDP (PPP) per capita

Gross domestic product (by purchasing power parity) per capita remains a key benchmark for assessing and comparing the prosperity of countries.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.510	0.000	0.309	0.000
Geary's C	0.468	0.000	0.687	0.000

The percentile cartogram (Fig. 3.1.1) shows that countries with the highest GDP values are concentrated in Northern and Western Europe around Germany, as well as the United States, several countries on the Arabian Peninsula (Qatar, the United Arab Emirates, Kuwait, Saudi Arabia, Oman), Israel, Brunei, and Singapore. The majority of countries with the lowest GDP per capita are located in Africa. Generally, the cartogram allows us to say that the world is roughly divided into North and South.

Notably, leaders in GDP (PPP) per capita are small countries whose prosperity rests on specializing in high value services that require a highly qualified workforce. Other cases include superprofits from oil trade — Qatar is such an example.

Large countries with more diversified economies have sectors with far thinner profit margins, and given their large populations, they have lower GDP (PPP) per capita.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.1.3) identifies two clusters, one with high GDP per capita and one with low GDP per capita. The first and largest is the European cluster, with which Russia aligns. It is the locus of states with diversified economies and sufficiently high labour productivity. It is characteristic that most countries of the Eastern and South-Eastern Europe are left out of this group. The second cluster located in Africa has low GDP per capita and spans the world's poorest countries.

The geopolitical neighbourhood matrix cartogram (Fig. 3.1.4) identifies two spatial clusters. One — the Euro-Atlantic cluster — demonstrates high GDP (PPP) per capita. This geopolitical bloc has six exceptions

Global place	Country	Indicator (int. dollar)
1	Luxembourg	116,786.5
2	Singapore	100,051.4
3	Qatar	96,732.7
Mean (63)	(Equatorial Guinea)	20,730.9 (20,396.5)
Median (91)	Paraguay	13,153.2
179	Malawi	1,067.1
180	Central African Republic	955.1
181	Burundi	779.5

that lag behind in this indicator: Ukraine, Georgia and four Balkan states — Serbia, Bosnia and Herzegovina, Macedonia, and Albania. What these countries have in common is that they all have suffered devastating civil wars in the recent past, they do not have significant deposits of expensive extractable resources, and have relatively low labour productivity. Another cluster, in African, has low GDP per capita.

We can also mention another mini-cluster of “errors”: Australia and New Zealand, forming the core of a geopolitical cluster that also includes 13 countries of Oceania, greatly outstrip these 13 states in terms of their prosperity levels since they have more advanced economies. Consequently, they are in the group of states with high GDP (PPP) per capita, although neighbourhood logic dictates they have lower indicator values, like their neighbours.

Unlike the geographic neighbourhood matrix, the geopolitical matrix allows researchers to combine the countries of Europe into a single cluster with their rich trans-oceanic partners, the United States and Canada. At the same time, Russia is no longer a member of this cluster as it belongs to another geopolitical bloc.

Under the geopolitical matrix, the African cluster of poor states expands somewhat. This demonstrates that sub-Saharan integration alliances span countries that are homogeneous in their low GDP per capita. It is noteworthy that rich states on the Arabian peninsula do not form any cluster since their neighbours in the Middle East and North Africa are far poorer than those states.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “GDP (PPP) per capita” parameter (Fig. 4.1.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram clearly shows the prerequisites of European integration since the region is the locus of a node of states with similar GDP per capita. Moreover, Europe is clearly split into Western European and Eastern European clusters. Additionally, there are visible clusters with similar levels of GDP per capita in West Africa, a poverty zone of sorts.

Clusters that did not emerge are interesting in this case, too. For instance, there is no node of connections in the Middle East, which shows high differentiation in the region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Inbound tourism	0.120	0.000	0.361	1.086
2	Population growth	0.080	0.000	-0.280	0.980
3	Access to electricity	0.229	0.000	0.412	0.741
4	Conservation areas	0.026	0.03	0.138	0.732
5	Depletion of natural resources	0.035	0.015	-0.157	0.704
6	Maternal mortality	0.247	0.000	-0.414	0.694
7	Particulate air pollution	0.149	0.000	-0.319	0.683
8	Poverty level	0.373	0.000	0.503	0.678
9	Infant mortality	0.385	0.000	-0.509	0.673
10	Elderly population	0.317	0.000	0.460	0.668

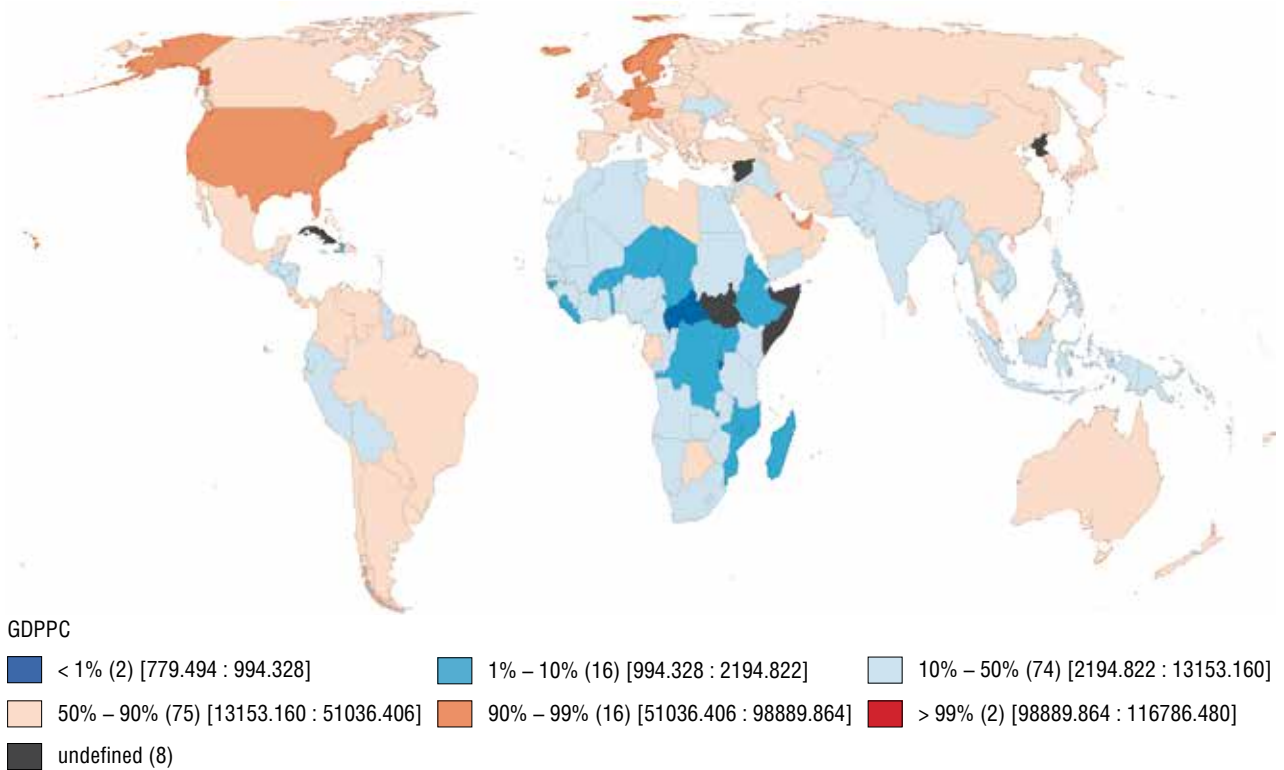


Fig. 3.1.1. Percentile cartogram for the “GDP (PPP) per capita” indicator

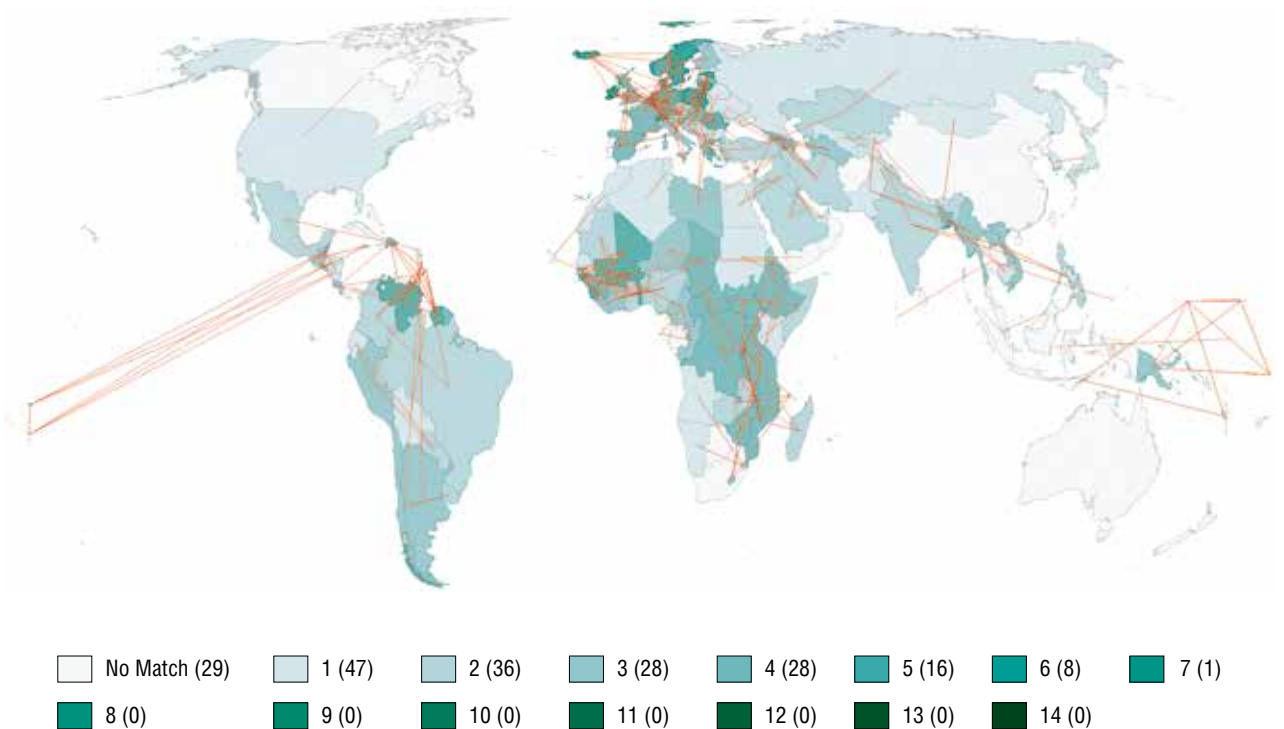


Fig. 3.1.2. Likelihood-ratio test for the “GDP (PPP) per capita” parameter

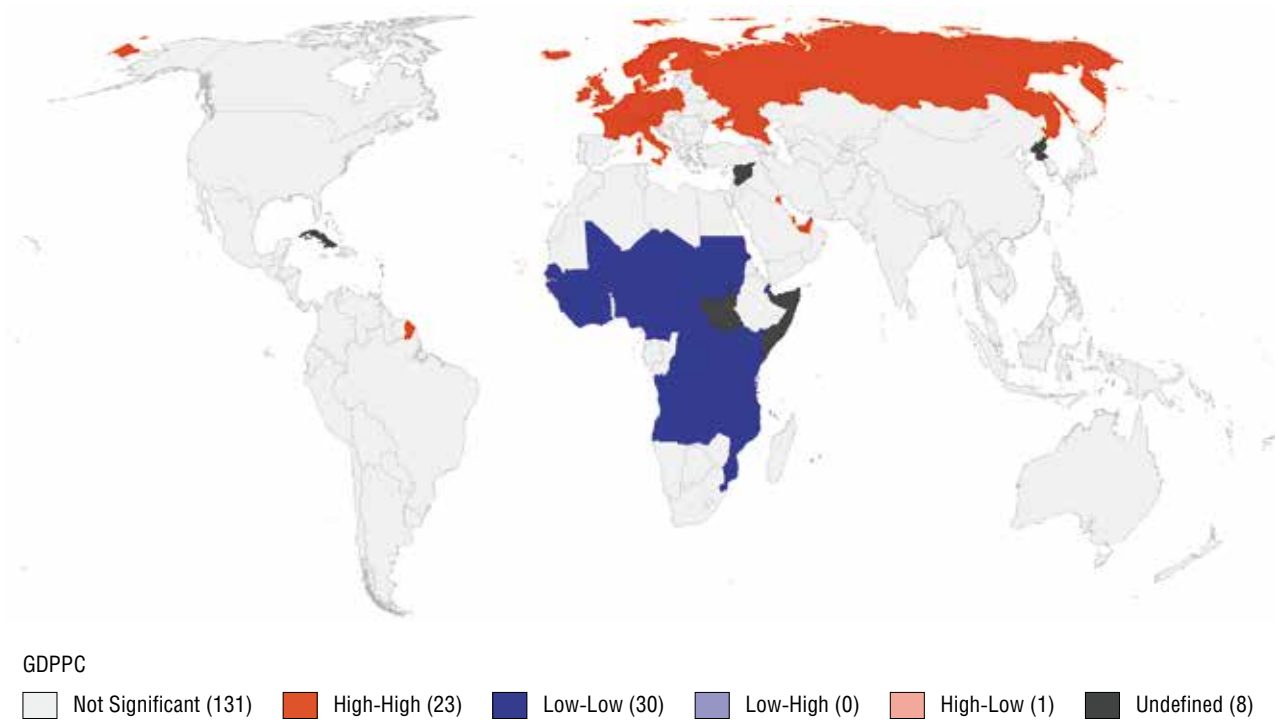


Fig. 3.1.3. “GDP (PPP) per capita” spatial autocorrelation cartogram for the geometric neighbourhood matrix

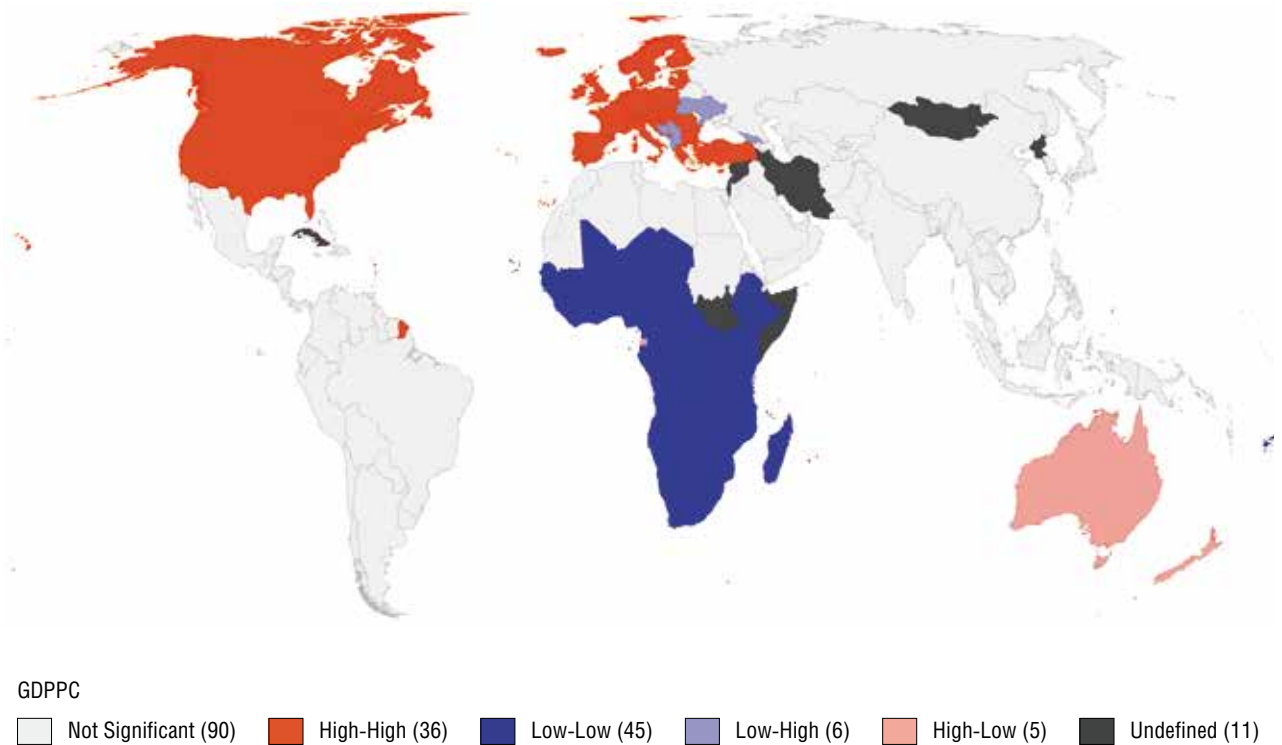


Fig. 3.1.4. “GDP (PPP) per capita” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.2. Agriculture

The added value of agricultural products is one of the basic indicators used for analysing a given state's economy.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.068	0.006	0.035	0.016
Geary's C	1.840	1.000	0.96	0.016

The percentile cartogram (Fig. 3.2.1) shows that countries with the highest indicator values are mostly developing states. China and India significantly outstrip other countries in this respect. Among developed states, several countries from Central and Southern Europe, namely, France, Spain and Italy, belong in this group, as does the United States.

Notably, the leaders in this indicator are countries with large territories and climates that are conducive to the development of the agricultural sector. Other factors include large populations, sizable domestic markets and increased domestic demand for food production.

Additionally, the agricultural sector of most developed states accounts for just 1–2% of their GDP, and their agricultural production volume is not particularly large as they are transitioning to the post-industrial and knowledge-intensive stage of their socioeconomic development.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.2.3) does not show any clusters, only separate countries with higher or lower agricultural production value. Among the countries with higher value that have not been mentioned is the Republic of Korea. Given their limited land resources and the fact that agricultural production makes up a paltry share of their economies (less than 2% of their GDP), their performance in this indicator values attest to their highly intensive and productive agricultural sectors. In South East Asian cluste includes Malasia and the Philippines. The latter is marked as an “error” on the cartogram since it neighbours on the micro-state of Brunei and the island country of Palau, with the former specializing in hydrocarbon production and the latter in tourism.

A number of Asian countries including Kazakhstan, Mongolia, the states of South Caucasus and Afghanistan fall into the “error” group, which attests to the uneven distribution of agricultural production between

Global place	Country	Indicator (int. dollar, millions)
1	China	978,615
2	India	418,010
3	US	177,932.58
Mean (34)	(UK)	18,360 (18,062.08)
Median (102)	(Laos)	2,928 (2820.39)
180	Palau	9.02
181	Tuvalu	5.86
182	Nauru	3.64

countries due to both natural and climate circumstances as well as the level of technological development. These states neighbour on large agricultural manufacturers: China, India, Russia, Iran and Turkey. It is likely that the increased level of the statistical mistake could allow to show not only scattered cases of “mistakes”, but also the cluster of leaders by the considered parameter.

The geopolitical neighbourhood matrix cartogram (Fig. 3.2.4) identifies a huge high-value cluster in East and Southeast Asia. States in this cluster have competitive, diversified agriculture due to their climate, government policies, and the high percentages of people employed in the agricultural sector. These countries produce and export rice, cocoa, tropical fruits, sugar cane and other crops. Forestry and fishery are sufficiently developed, as is animal husbandry, albeit to a lesser extent (with the exception of China). A group of “errors” with low values is formed by three countries in Indochina. This group is characterized by low economic growth and low labour productivity, even though the overwhelming majority of their populations is employed in the agriculture sector.

Low-value clusters are located in Southern Africa and in the Balkans. These states are characterized by general economic backwardness, political instability, and a shortage of land resources and fertile soil. South Africa is included in this cluster despite its more productive agricultural sector, which can be explained by its indicator values being relatively low compared to the global mean.

The cartogram shows a gap between the countries of South America. Despite their above-average indicator values, the Pacific coast, Bolivia and Paraguay form a low-value cluster because they neighbour a large producer, namely, Brazil.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Agriculture” parameter (Fig. 3.2.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. Here, we observe an area of intensive agriculture in Southeast Asia. We can also identify a South European cluster whose states are located in the same climatic zone and have similar cultures of agricultural production. Similar figures are observed in the Andean states of South America.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Tax revenues	0.034	0.034	−0.97	0.277
2	Marriage	0.038	0.008	0.098	0.253
3	Rate of gross accumulation	0.027	0.032	0.081	0.243
4	Religious diversity	0.025	0.034	0.06	0.144
5	Poverty	0.028	0.041	−0.052	0.097
6	Load on freight ports	0.821	0	0.129	0.02
7	Loans to domestic companies	0.058	0.001	0.034	0.02
8	Film industry	0.103	0.001	0.04	0.016
9	Diplomatic missions	0.202	0	−0.052	0.013
10	Light pollution	0.329	0	0.059	0.011

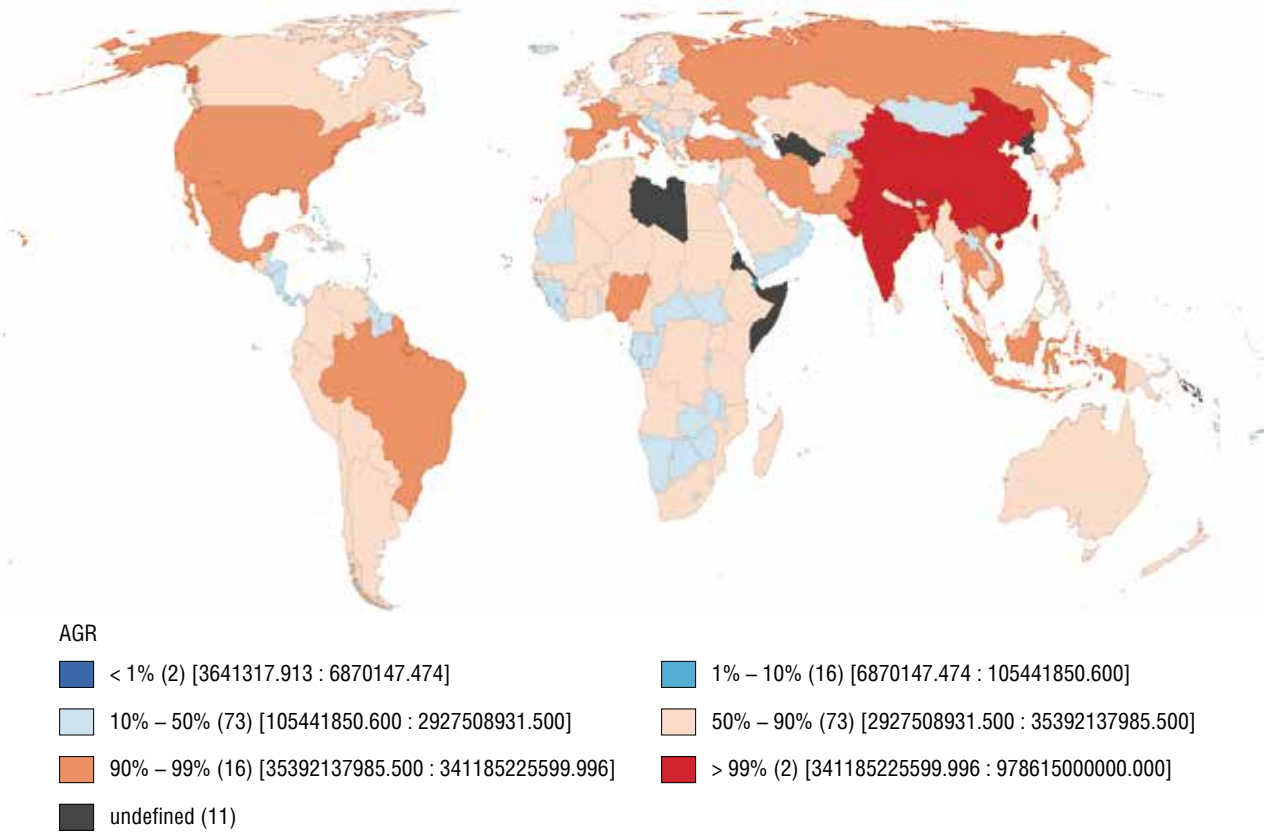


Fig. 3.2.1. Percentile cartogram for the “Agriculture” indicator

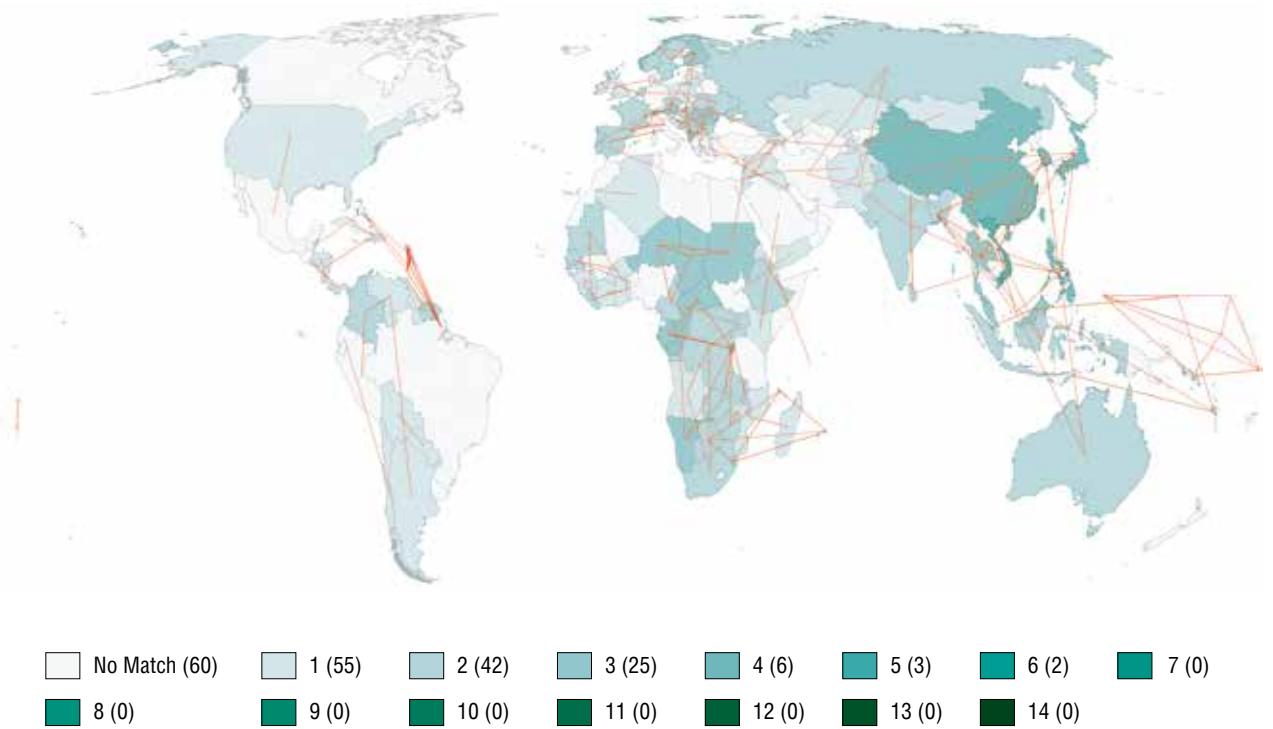


Fig. 3.2.2. Likelihood-ratio test for the “Agriculture” parameter

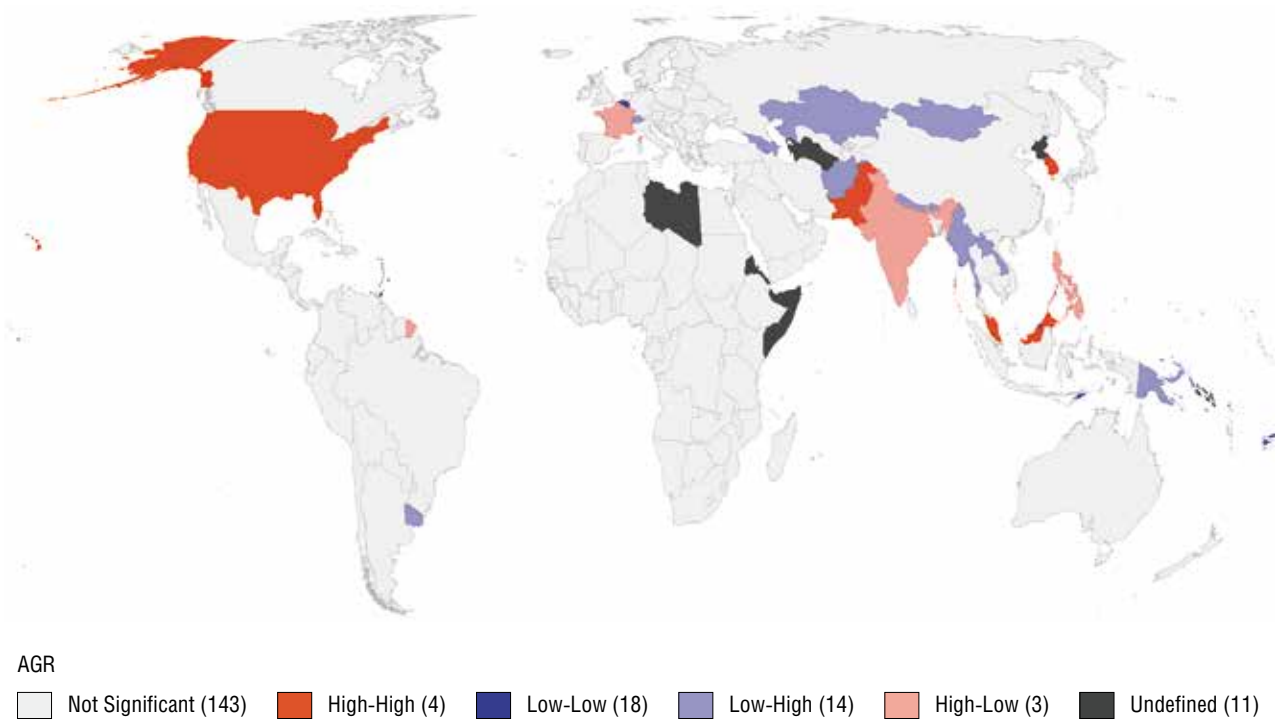


Fig. 3.2.3. “Agriculture” spatial autocorrelation cartogram for the geometric neighbourhood matrix

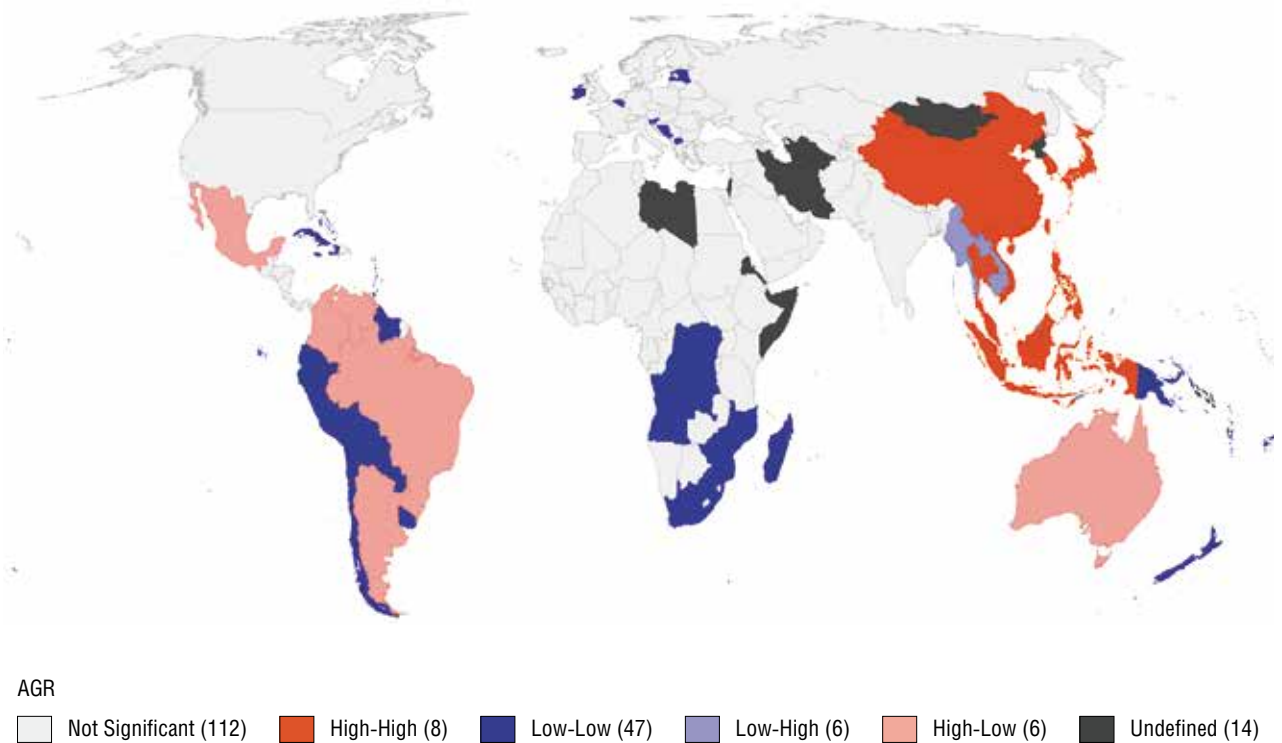


Fig. 3.2.4. “Agriculture” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.3. Industry

The economic potential of a country is determined by its level of industrial production, which is one of the basic indicators for assessing a given state's standing in the global economy. Factors that determine this indicator are natural and human resources, domestic and foreign demand, and the efficiency of the state's industrial policy.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.064	0.028	0.042	0.021
Geary's C	1.546	0.999	0.953	0.021

The percentile cartogram (Fig. 3.3.1) shows two clear leaders of rival groups of states: the developed economies of the collective West, and rapidly developing Asian states. The first group is led by the United States, and the second by China. Above-average industrial production levels are observed in the overwhelming majority of South American countries, with Brazil significantly outstripping all other countries. Some African states also demonstrate above-average indicator values. However, on the whole, the continent lags significantly behind other regions, as it has the largest number of states with low values. At the same time, African countries owe their above-average values to their extractive industry, even though their economies are still dominated by agriculture. We should note that this indicator covers all industrial sectors regardless of how knowledge-intensive they are. In this respect, it is interesting that UNIDO classifies China as a country with a developing industry, despite the fact that it demonstrates the highest values for this indicator.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.3.3) identifies only one small cluster in East Asia. This cluster includes Japan and South Korea, countries with limited natural resources. However, both are developing knowledge-intensive and manufacturing sectors: car manufacturing, shipbuilding, electronics, etc.

Global place	Country	Indicator (int. dollar, million)
1	China	5,514,440
2	US	3,835,854
3	Japan	1,440,460
Mean (154)	(Iraq)	125,700 (125,792)
Median	(Cameroon)	9,778 (9,975.94)
180	Micronesia	1.96
181	Nauru	5.5
182	Tuvalu	2.58

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 3.3.4) clearly demonstrates high differentiation for this indicator within geopolitical blocs. For instance, lesser developed countries in Eastern and Southeast Europe (with the exception of Poland), the Baltic states, and the countries of Northern Europe stand out in the bloc of European and North American countries. They lag behind because of their lower labour productivity, limited resource potential, and small workforce.

In Latin America, Brazil and Venezuela demonstrate high values. Brazil has developed extractive, oil processing, chemical, and engineering industries. Venezuela's high indicator is due to oil production.

There is also a gap in East and Southeast Asia, where such industrial giants as China, South Korea, Japan neighbour Indochina's least developed states (Myanmar, Laos, Cambodia). At the same time, several states have developed processing (Vietnam) and extractive industries (the Philippines) that nevertheless cannot match the production levels of their large neighbours.

Two low-value clusters are observed in West and South Africa, where some of the world's poorest states with economies that depend on monoculture agriculture are located. Notably, this cluster includes oil-rich Nigeria, which demonstrates the highest GDP (PPP) in Africa. Nevertheless, industrial development on the continent is hampered by domestic conflicts, unstable political systems, and the activities of terrorist organizations.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Industry" parameter (Fig. 3.3.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. Several regional clusters are identified here: in Eastern Europe, Central Europe, Southeast Asia (ASEAN countries), West Africa, the Middle East, and North America. Therefore, industrial production is similar at the regional level. This is possibly due to countries being located in the same climate zone, meaning that they have more or less the resources available to them, similar political and business cultures, common historical economic development backgrounds, etc.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Bioethical freedom	0.036	0.019	0.163	0.738
2	Quality of school education	0.043	0.007	0.153	0.544
3	Years at school	0.023	0.043	0.104	0.470
4	Internet users	0.028	0.026	0.104	0.386
5	Infant mortality	0.027	0.027	-0.1	0.370
6	Publication activity	0.028	0.024	0.097	0.336
7	GDP (PPP) per capita	0.031	0.018	0.099	0.316
8	Life expectancy	0.033	0.016	0.102	0.315
9	Young population	0.041	0.007	-0.11	0.295
10	CO ₂ emissions	0.036	0.011	0.101	0.283

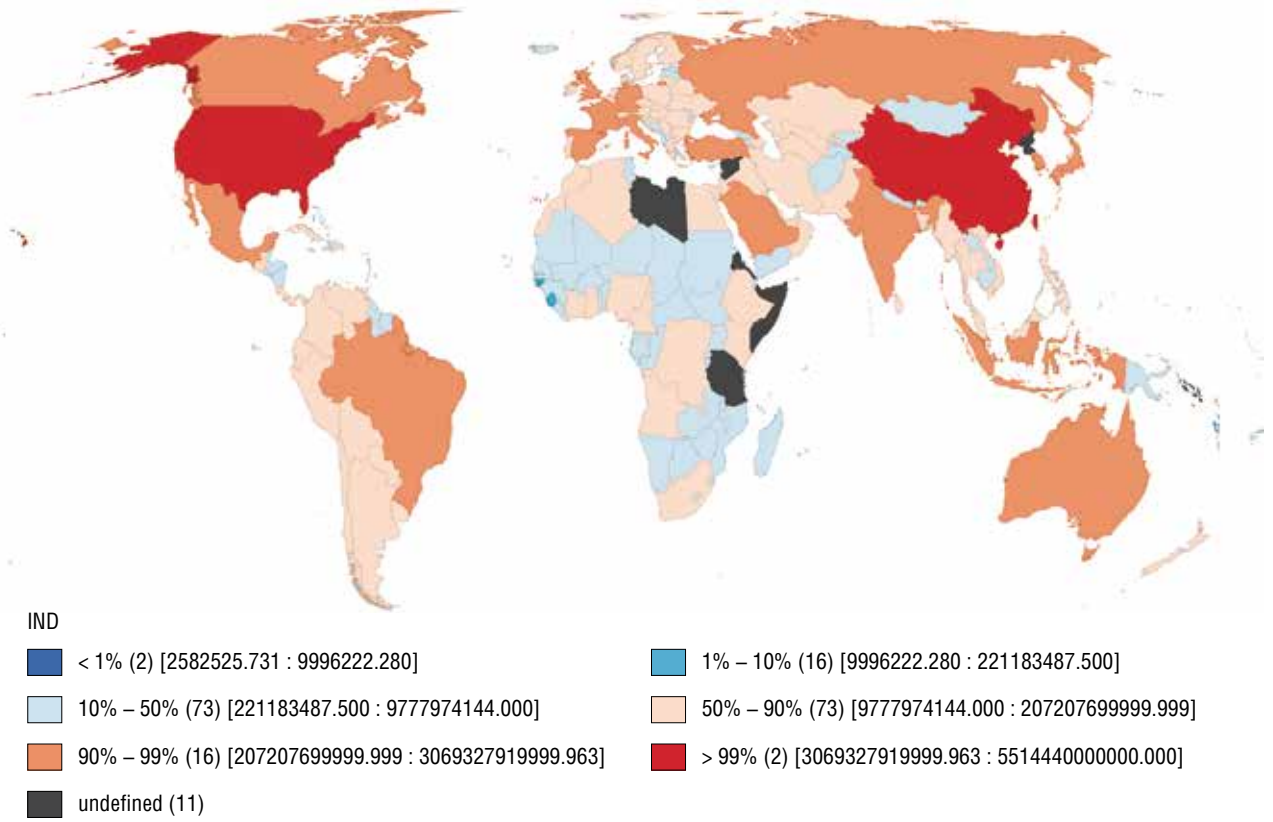


Fig. 3.3.1. Percentile cartogram for the “Industry” indicator

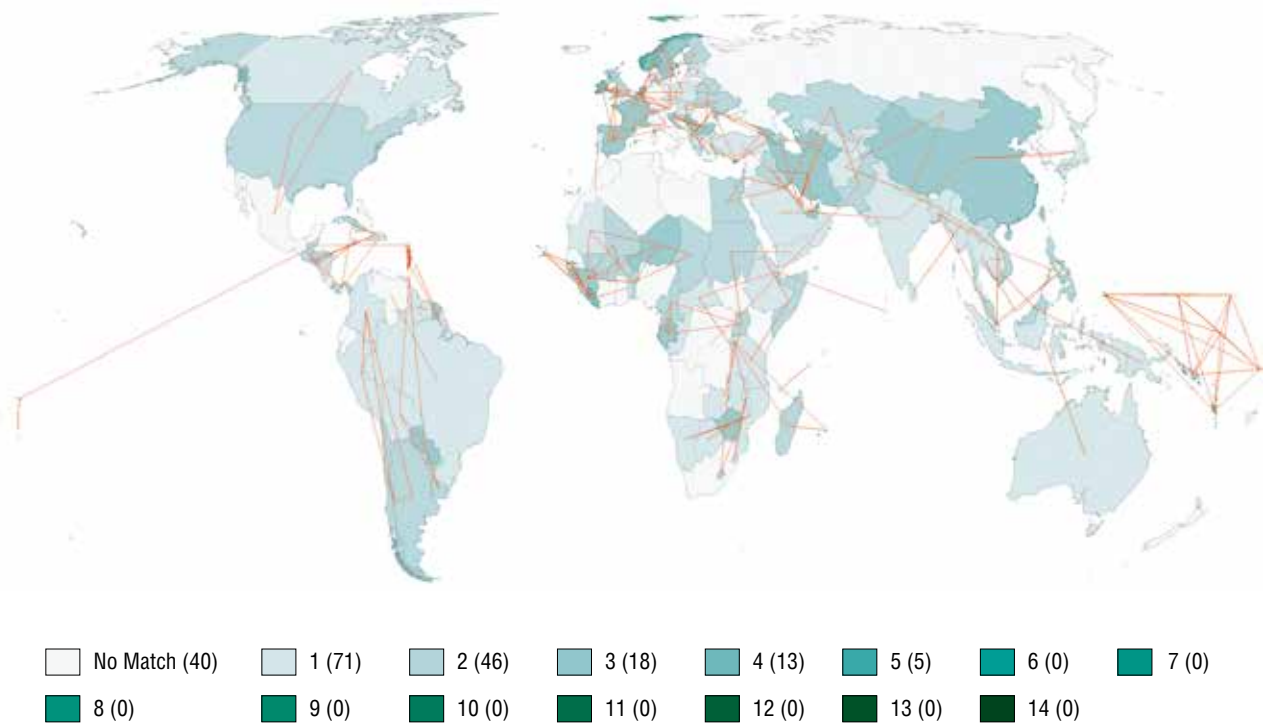


Fig. 3.3.2. Likelihood-ratio test for the “Industry” parameter

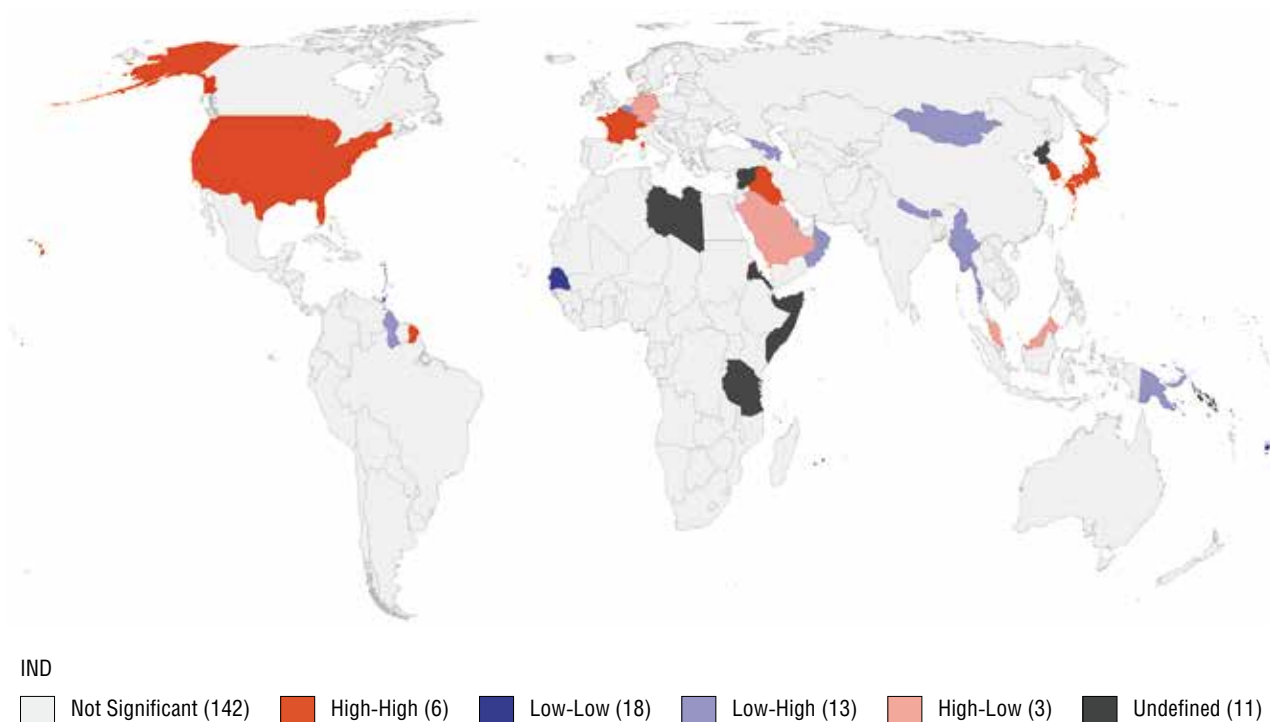


Fig. 3.3.3. “Industry” spatial autocorrelation cartogram for the geometric neighbourhood matrix

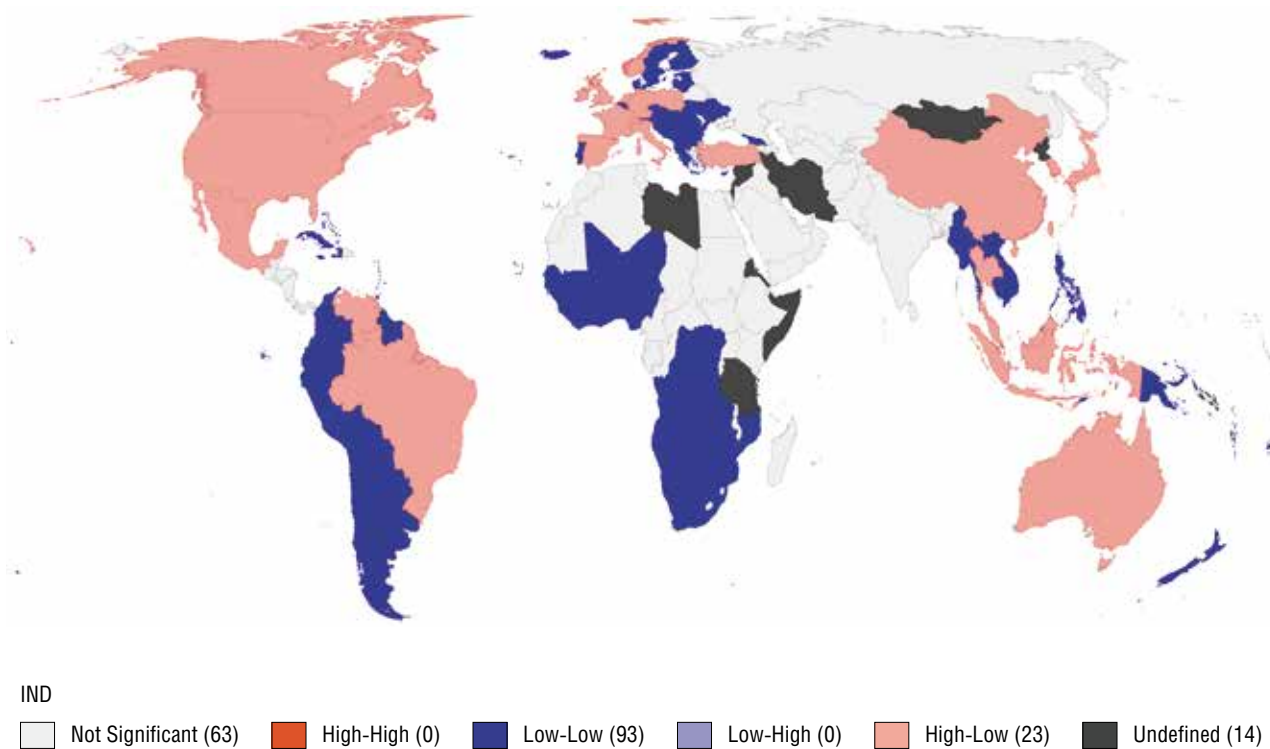


Fig. 3.3.4. “Industry” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.4. Medium- and hi-tech industries

A comparative analysis of the share of medium- and hi-tech products in the production of countries shows the degree of a given state's transition from resource-based and low-tech manufacturing to medium- and hi-tech production and, consequently, to a more complex national economic structure.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.413	0.000	0.350	0.000
Geary's C	0.580	0.000	0.647	0.000

The percentile cartogram (Fig. 3.4.1) shows two regions where states with the highest indicators are concentrated: Western and Northern Europe, and the developed countries of East Asia (Japan and South Korea).

Interestingly, most countries demonstrate above-average indicators, which suggests a gradual evening-out of manufacturing development and investment into knowledge-intensive production in countries across the globe.

Exceptions here are in Africa, Central, South and Southeast Asia, Oceania, and on the Pacific coast of South America. This is due to the general economic backwardness of the countries in these regions, their reliance on agriculture and the extractive industry, and the low human capital development levels.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.4.3) identifies a large European cluster that, interestingly, does not include Spain, Portugal and the Eastern European states. This cluster is made up of developed states that have diversified production despite limited natural resources and invest large amounts into human capital and R&D. These states also demonstrate high "knowledge economy" indicators (EBRD), which allows us to make the assertion that they developed education systems, information infrastructures, and innovation-based economies. These factors are conducive to creating a favourable environment for developing science and hi-tech manufacturing.

An "error" cluster includes China, Vietnam and Thailand, which exhibit high indicator values relative to their neighbours, where the majority of the population is employed in agriculture (Myanmar, Laos, Cambo-

Global place	Country	Indicator (%)
1	Singapore	80.46
2	Switzerland	64.56
3	South Korea	63.83
Mean (82)	(South Africa)	24.31 (24.42)
Median (74)	Egypt	20.94
145	Yemen	2.06
146	Tonga	1.61
147	Cambodia	0.26

dia). China's explosive growth since the 1980s determined its manufacturing development, the influx of investment into the IT sector, and the establishment of the country's tech giants. Economic reforms ensured high economic growth rates in Vietnam and Thailand in the 1980s–1990s, which allowed them to develop several knowledge-intensive sectors while preserving a large agricultural sector. At the same time, globally, these countries are ranked 29–31 and do not form a separate high-value cluster.

Spatial autocorrelation analysis under the geopolitical neighbourhood matrix (Fig. 3.4.4) demonstrates significant differences. We can observe two extra-large clusters with high indicator values. In addition to the countries mentioned above, the first cluster includes states of North America and Southern and Eastern Europe. Therefore, we can identify a trans-Atlantic cluster of developed countries. This cluster does not, however, include Iceland, the Baltic countries, and Greece, states that are dominated by low-tech manufacturing, the extractive industry (Bosnia and Herzegovina) or light and food industries (Greece, Iceland). Notably, this cluster now includes Turkey, one of the world's fastest-growing economies with developing automotive, chemical and electronic industries.

The second cluster is formed by rapidly developing states of East and Southeast Asia that compete today with developed states.

Low-value clusters are located in East and Southern Africa, economies that are dominated by agriculture and the extractive industry. In comparison, South Africa, the most economically developed country on the continent that boasts large engineering and chemical industries, demonstrates relatively high indicator values.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Medium- and hi-tech industries” parameter (Fig. 3.4.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The highest similarity of indicator values is observed in the Western European cluster of high values and in three African clusters with low levels of medium- and hi-tech manufacturing. Neighbouring states in Latin America and Asia manifest clearly visible gaps in this indicator.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Ethnic fractionalization	0.04	0.022	−0.238	1.416
2	Particulate air pollution	0.055	0.006	−0.258	1.21
3	Economic inequality	0.136	0	−0.38	1.062
4	Ethnic minorities	0.062	0.002	−0.252	1.024
5	Highly wealthy population	0.159	0	−0.398	0.996
6	Availability of electricity	0.135	0	0.319	0.754
7	Access to electricity	0.175	0	0.353	0.712
8	Conservation areas	0.032	0.03	0.15	0.703
9	Tuberculosis morbidity	0.138	0	−0.305	0.674
10	Number of doctors	0.228	0	0.378	0.627

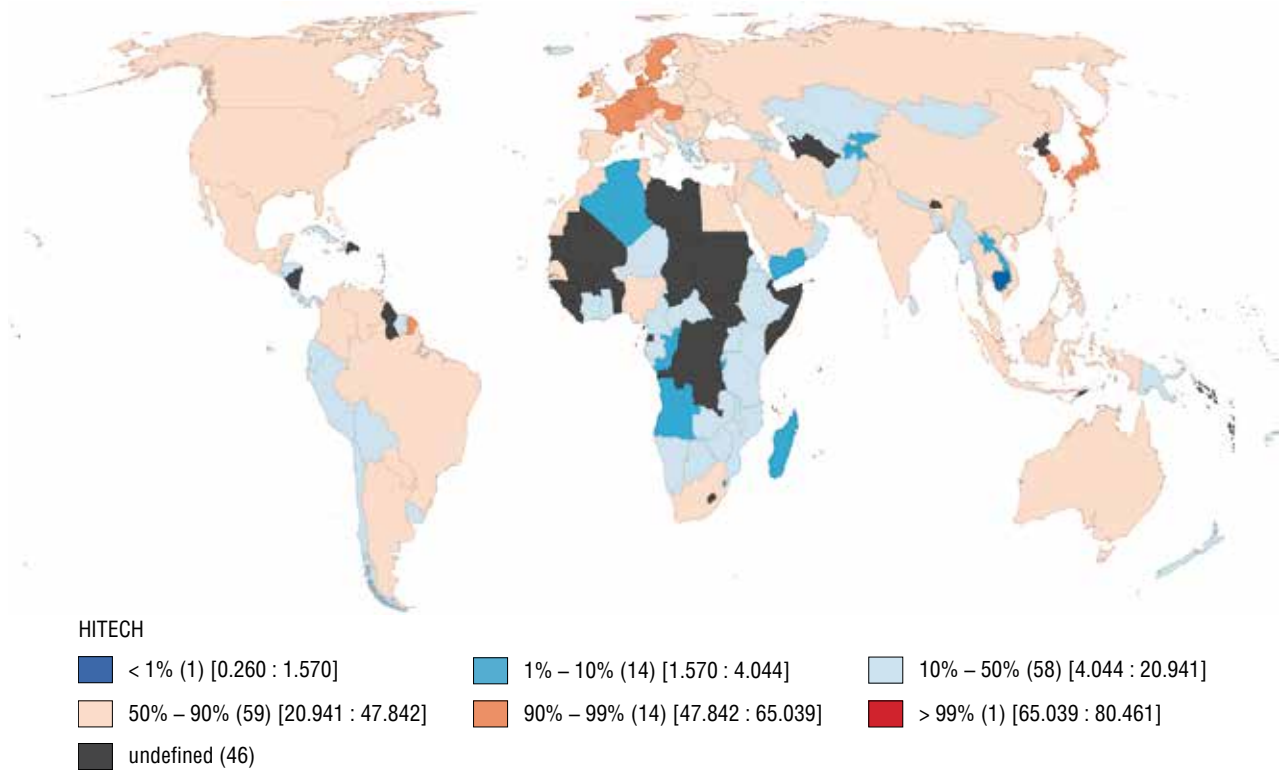


Fig. 3.4.1. Percentile cartogram for the “Medium- and hi-tech industries” indicator

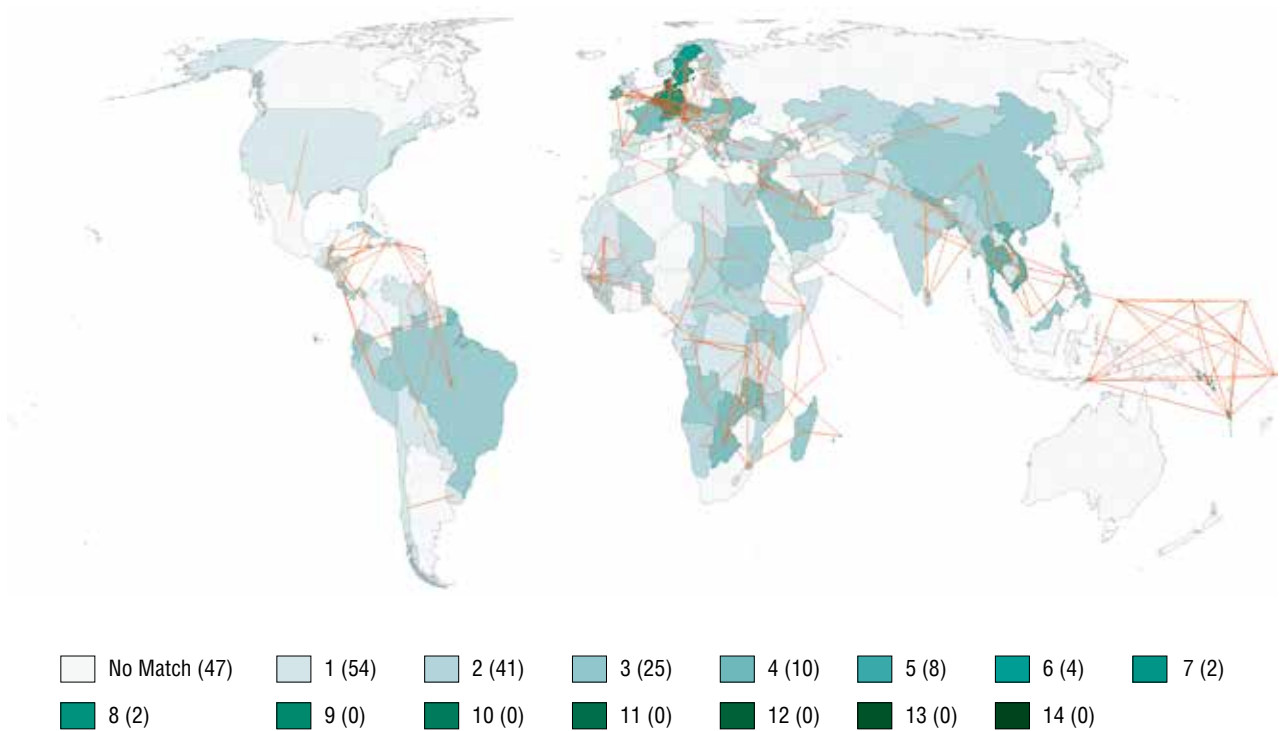


Fig. 3.4.2. Likelihood-ratio test for the “Medium- and hi-tech industries” parameter

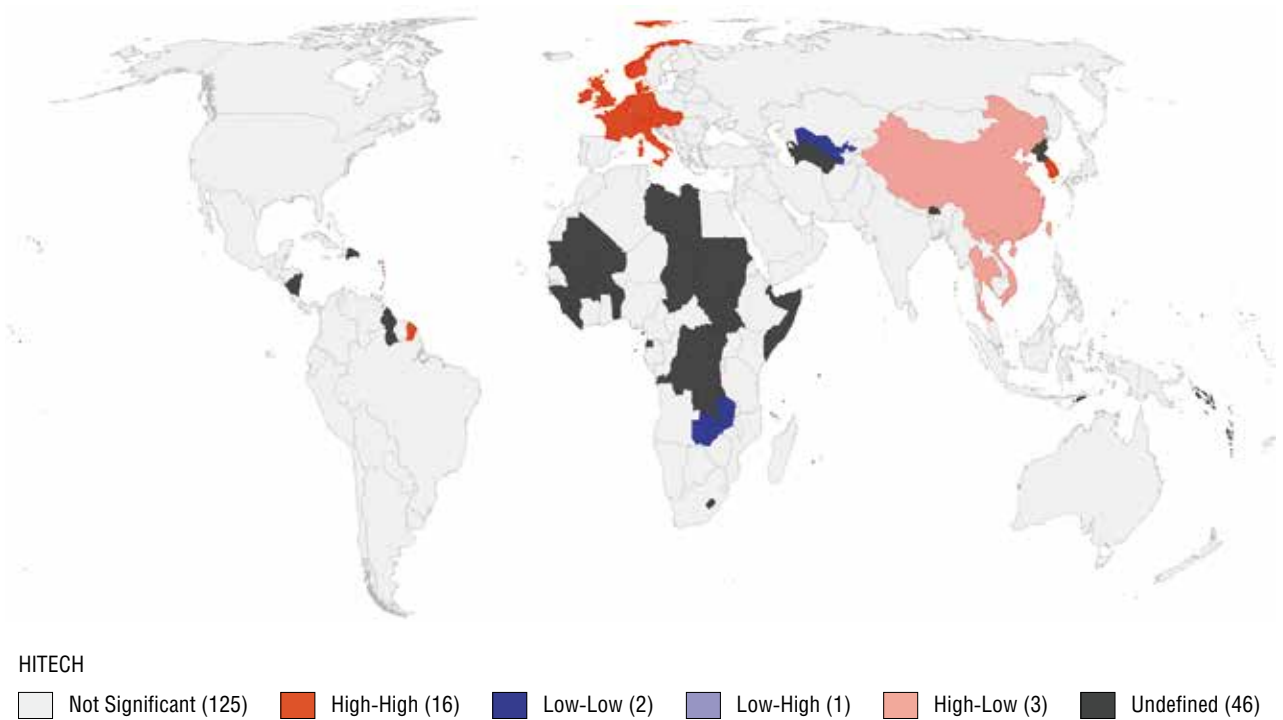


Fig. 3.4.3. “Medium- and hi-tech industries” spatial autocorrelation cartogram for the geometric neighbourhood matrix

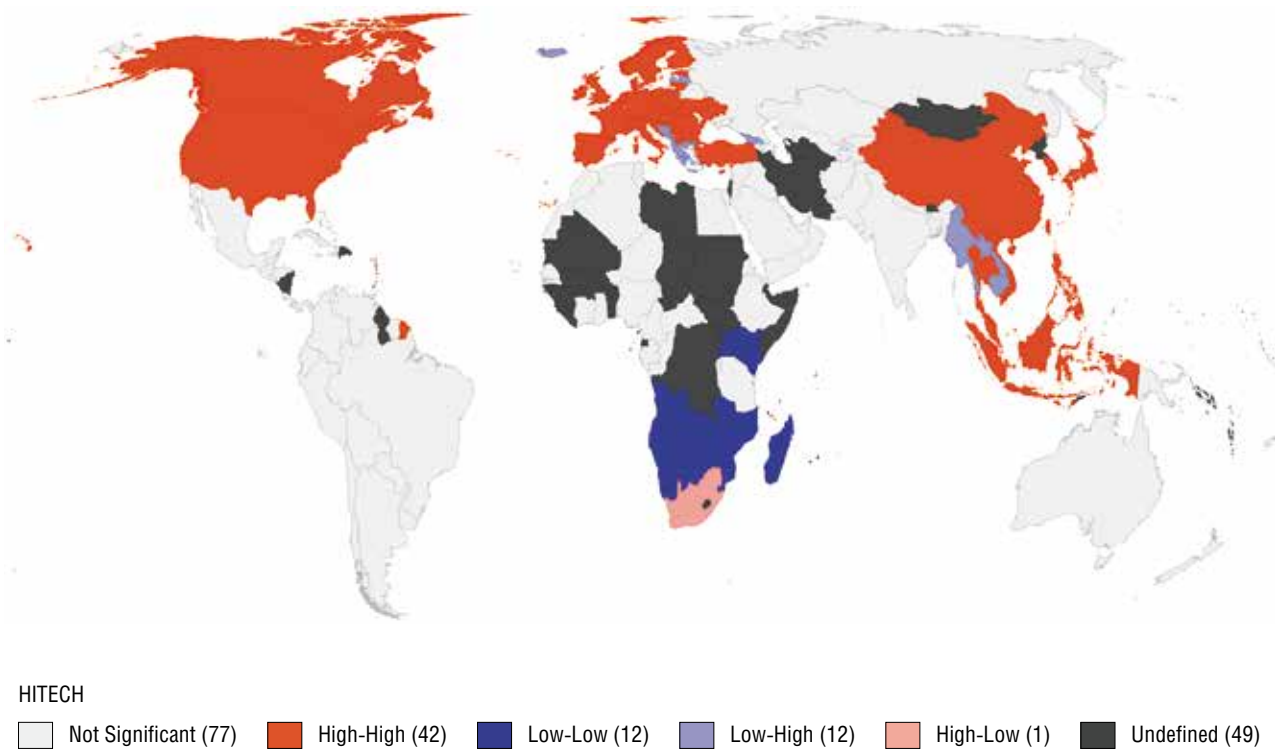


Fig. 3.4.4. “Medium- and hi-tech industries” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.5. Rate of gross accumulation

Accumulation is a necessary condition for expanding national economic reproduction and, as consequently, for meeting growing needs. It is also a source of investment. As a rule, there is a direct dependence between gross national rate of accumulation and economic growth rates.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.202	0.000	0.065	0.010
Geary's C	0.796	0.000	0.930	0.010

Gross investment rates are connected to a series of factors: savings, capital saturation of the domestic market, demographic indicators, investment infrastructure development, state policies, political stability, etc.

The percentile cartogram (Fig. 3.5.1) shows that high rates of gross accumulation are typical for developing Asian states, as well as for several states in North and Southwest Africa. On average, rates of gross accumulation in developed countries are about 20–21% of their GDP (with the exception of the countries of Northern Europe), and about 24–26% of their GDP in developing countries, but some developing states demonstrate rates of 30% of GDP and higher.

During industrialization, countries need investments into capital-intensive sectors. As the share of services in the GDP grows and the role of human capital increases, rates of gross accumulation, as a rule, decrease.

The economic growth experienced by developing states in the 2000s was accompanied by an investment boom and an increase in savings activities (in other words, with growing rates of accumulation). This was particularly visible in China and in oil exporting countries. The global financial crisis and subsequent “credit crunch” of 2010–2013, which hit countries with high revenues particularly hard, was an additional factor that led to the drop in rates of accumulation.

Low indicator values in African countries are due to domestic political instability, weak governmental institutions, and low quality of life. People are not inclined, or indeed able, to save and accumulate when their incomes do not exceed the subsistence rate. Exceptions here are oil exporting states and investment importing countries.

Global place	Country	Indicator (% of the GDP)
1	Nepal	53.9
2	Maldives	51.79
3	Mozambique	49.03
Mean (101)	(Finland)	25.05 (25.1)
Median (87)	Cambodia	23.45
171	Malawi	10.87
172	Zimbabwe	9.35
173	South Sudan	5.75

Latin America demonstrates relatively low values. Venezuela, Guyana and Ecuador are exceptions, as they receive massive profits from sales of hydrocarbons.

The geometric neighbourhood matrix cartogram (Fig. 3.5.3) reveals a large cluster of high values in Asia. These are rapidly growing states of Central, South and East Asia. Their accelerated development was achieved thanks to high savings and accumulation. Later, this allowed India and China to become not only large investment recipients, but also to export excessive capital to developed and developing states.

Curiously, such states as Nepal, Bhutan and Kazakhstan made this cluster. This is due to the major influx of investment into countries with relatively small GDPs, which creates a statistical effect. Consequently, the rate of gross accumulation shows high indicator values despite low (in the cases of Nepal and Bhutan) industrialization and gross accumulation. A similar situation is observed in West Africa (Mauritania), where countries attract major investments.

The geopolitical matrix cartogram (Fig. 3.5.4) shows a high-value cluster in South and Southeast Asia. However, the general high values demonstrated by the countries in this region give way to an “error” group consisting of Afghanistan, Pakistan and Cambodia — poor states with unstable political regimes. This latter fact explains the negative economic expectations of the people in these countries and the lack of incentives to save. Malaysia is part of this “error” cluster because it neighbours on countries from the high-value cluster, even though the indicator values for Malaysia itself are close to the global mean (over 23% of its GDP).

A cluster of low values is revealed in Southern Africa. Several states (Mozambique, Zambia, Botswana, Lesotho) are part of an “error” group — their accumulation process is based on influxes of investments into their extractive sectors.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Rate of gross accumulation” parameter (Fig. 3.5.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram clearly shows an area of countries with high rates of gross accumulation in Asia, and a group of countries with low indicator values in the south of Africa. A “knot” of countries with similar indicator values is observed in Europe, which attests to the similar levels of their socioeconomic development.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Mobile subscribers	0.026	0.042	0.163	1.022
2	Marriage	0.028	0.029	0.163	0.949
3	Hepatitis B vaccinations	0.026	0.037	0.151	0.877
4	Particulate air pollution	0.037	0.016	0.15	0.608
5	Alcoholism	0.035	0.014	−0.137	0.536
6	Female population	0.042	0.008	−0.147	0.515
7	Agriculture	0.27	0.032	0.293	0.318
8	Regional trade agreements	0.025	0.039	−0.086	0.296
9	Petrol prices	0.058	0.002	−0.127	0.278
10	Elderly population	0.037	0.012	−0.092	0.229

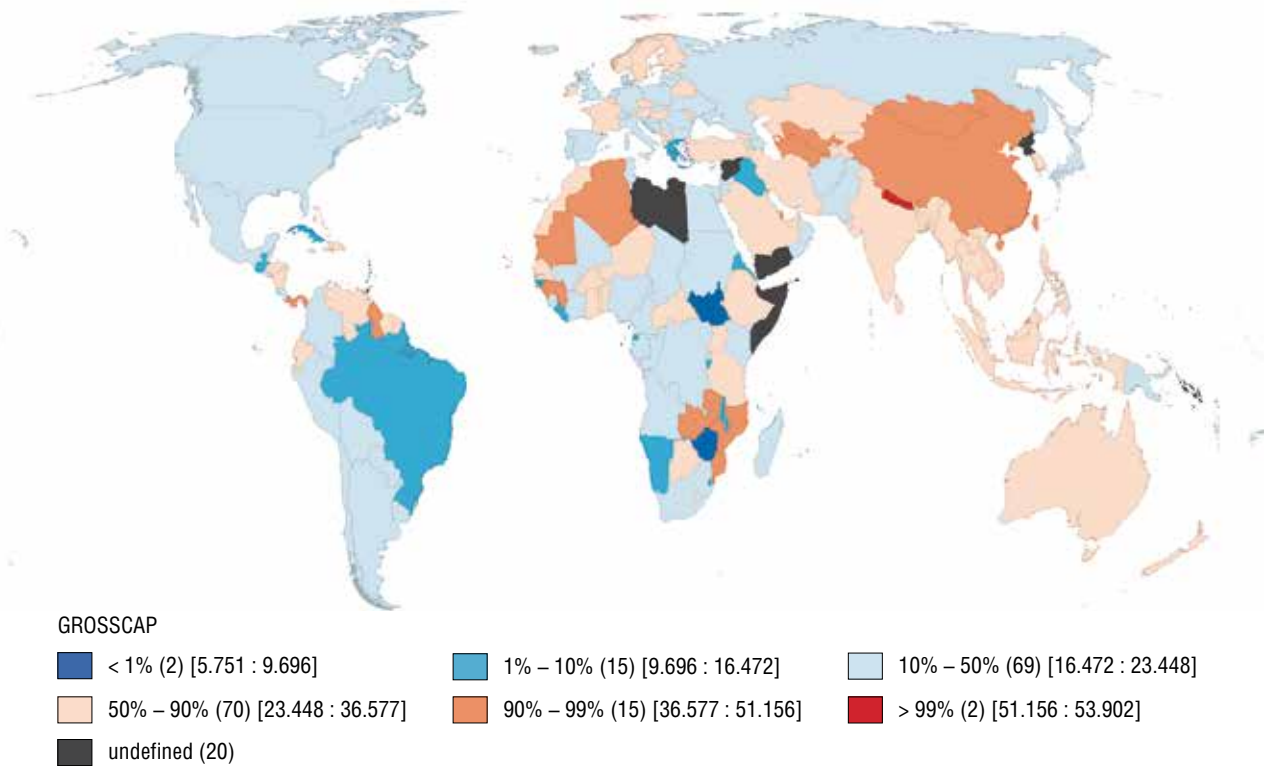


Fig. 3.5.1. Percentile cartogram for the “Rate of gross accumulation” indicator

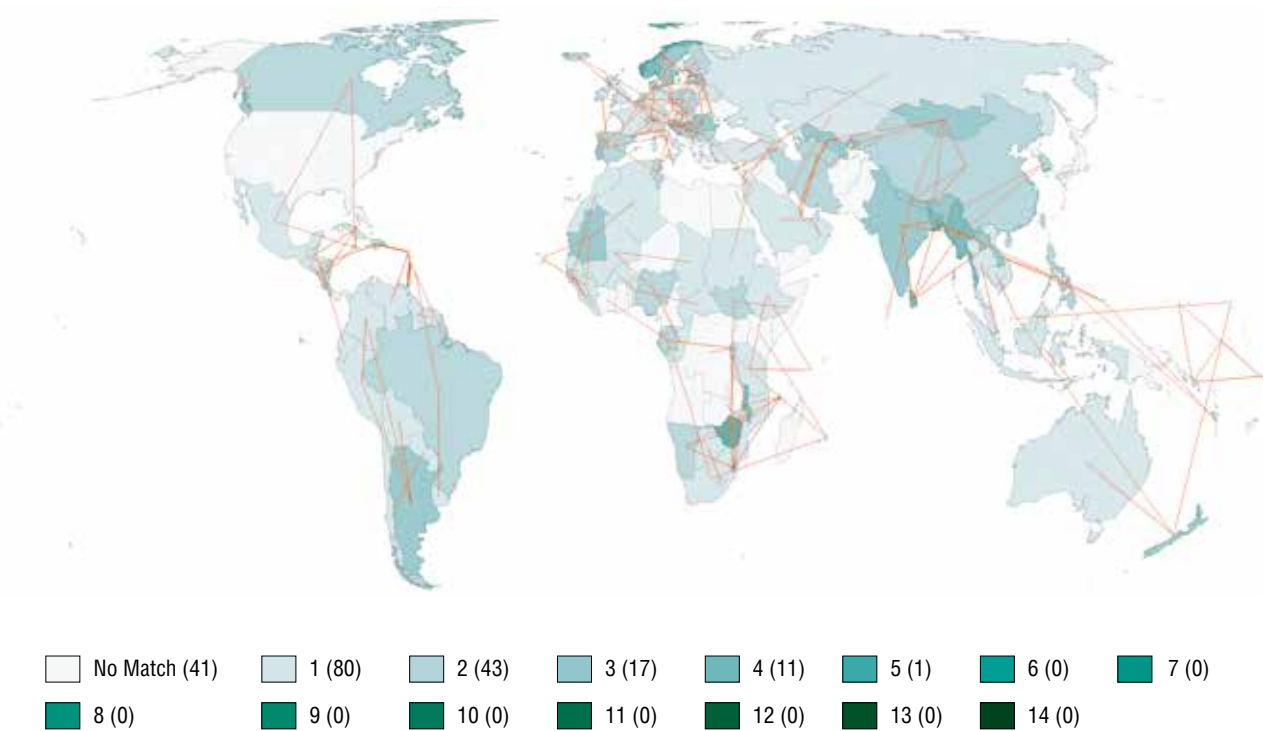


Fig. 3.5.2. Likelihood-ratio test for the “Rate of gross accumulation” parameter

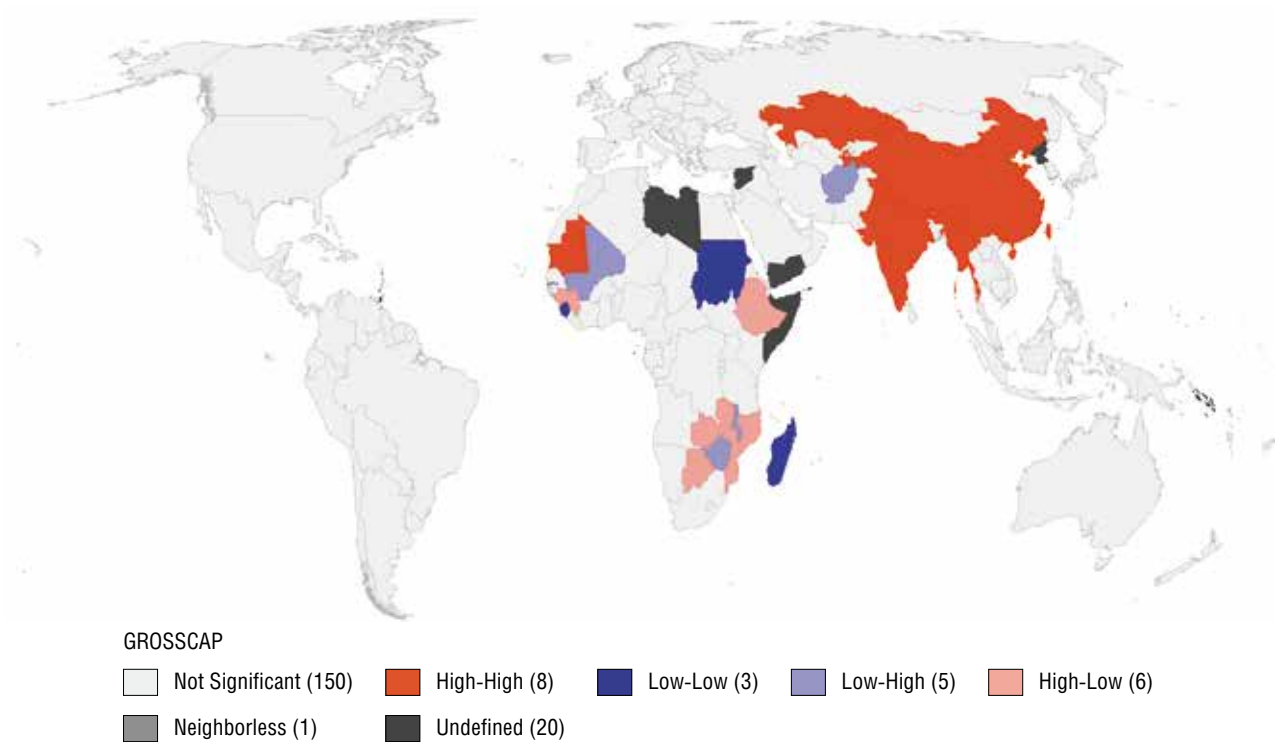


Fig. 3.5.3. “Rate of gross accumulation” spatial autocorrelation cartogram for the geometric neighbourhood matrix

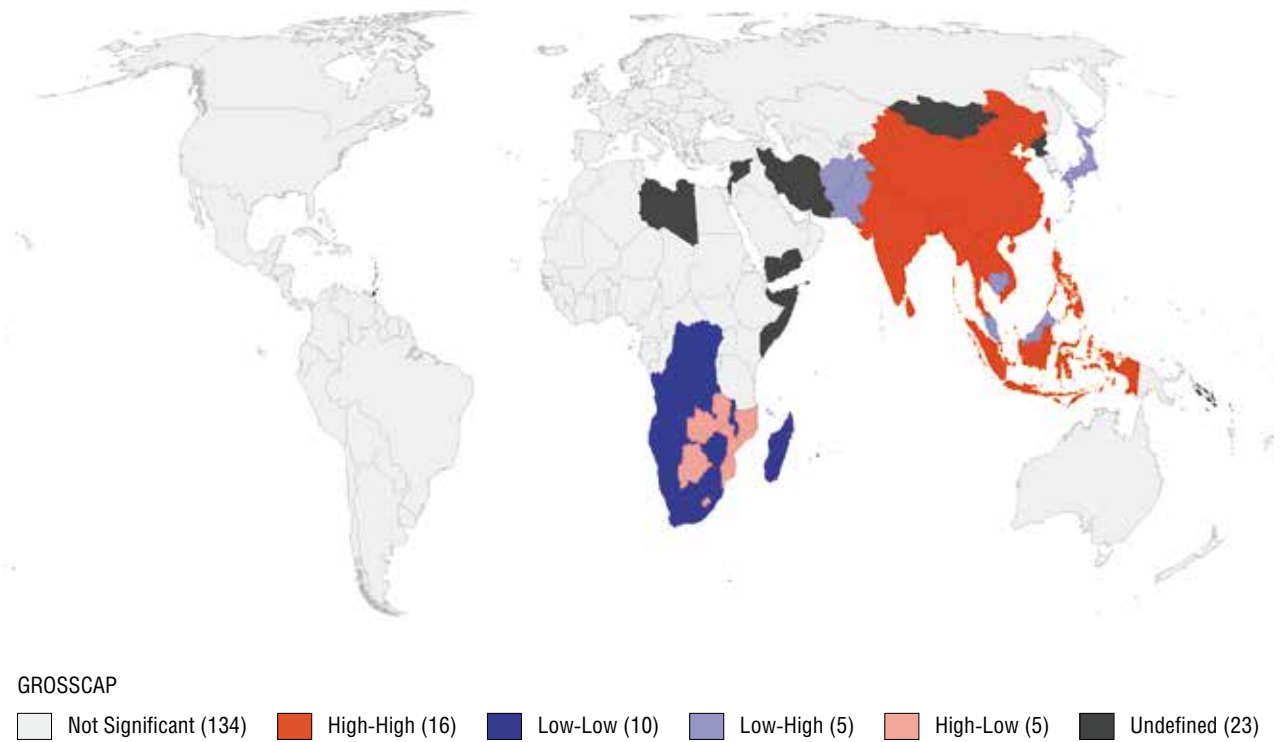


Fig. 3.5.4. “Rate of gross accumulation” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.6. Services sector

In order to provide a comprehensive picture of the state of the economies of different countries, this section analyses the services sector, which is represented as the added value of wholesale and retail trade; hotel and restaurant operations; transportation; management; financial, professional, and personal services such as education, healthcare and real estate services; banking fees; and import duties.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.536	0.011	0.020	0.089
Geary's C	0.956	0.398	0.975	0.089

The percentile cartogram (Fig. 3.6.1) shows that the leaders in this metric are the largest economic powers of the world: the United States, China and Japan, Western European countries, Brazil, India and Canada. Since the indicator is expressed in nominal terms and not as a per capita value, the list is mostly topped by large populous states with diversified economies. The largest and mostly rapidly developing sector in developed countries is the tertiary sector. The lowest values for the services sector are observed in underdeveloped African countries, as well as in small island states with small populations.

The mean global value for this indicator is significantly higher than the median value since the values of the leading countries are significantly higher than those of most countries.

The geometric neighbourhood matrix yields average spatial correlation.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.6.3) shows two clusters: two with a large services sector and one with a small services sector.

Both clusters with high indicator values are comprised of developed western countries: Canada and the United States on the one hand, and France, Germany, Belgium and Switzerland on the other. It is telling that Belgium and Switzerland (which are not large states) make the list; their large tertiary sectors are a result of their highly developed professional services sector, primarily in the financial sphere. An important factor for Belgium is that Brussels is home to key EU governing bodies that ensure a large share of managerial services on the one hand, and luxury consumption on the other. And such consumption, once again, is part of the services sector.

Connected with this cluster is Luxembourg, a country with relatively small services production. But the crucial factor here is the size of the country and its economy, which naturally do not allow it to compete

Global place	Country	Indicator (USD, million)
1	US	15,824,167.83
2	China	6,318,160
3	Japan	3,434,353.21
Mean (24)	(Poland)	302,800 (305,801)
Median (85)	(Cameroon)	18,930 (18,329.28)
166	Marshall Islands	134.1
167	Kiribati	126.33
168	Nauru	81.96

with France, the United States or Switzerland in this indicator. Still, the services sector (primarily financial services) is highly developed in Luxembourg — over half of the country's economically active population are employed in this sector, and it dominates the country's GDP.

A low-value cluster is located in Oceania and includes island states that have small populations and are on the periphery of international economic trends.

The geopolitical neighbourhood matrix cartogram (Fig. 3.6.4) shows eight low-value clusters and not a single high-value cluster because the countries here are grouped by political and economic alliances, whereas states with large and developed economies may have smaller neighbours. For instance, the United States, Canada and the countries of Western Europe that formed separate clusters with large services sectors under the geometric neighbourhood matrix, became members of the Euro-Atlantic group of countries under the geopolitical matrix. And this group is mostly composed of small states where some, for instance those in Eastern Europe, do not have equally high services sector productivity. Consequently, the highly developed countries of Western Europe and North America were placed in an “error” cluster, since most their neighbours do not have equally high services sector production.

China, Japan, South Korea and Indonesia turned out to be exceptions in South and Southeast Asia, Australia was an exception in the Oceanic cluster of low values, and Brazil is surrounded by countries with small services sectors. There are no high-value countries adjacent to the West African cluster of low values.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Services sector” parameter (Fig. 3.6.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The most visible nodes here are located in Europe, West and Southern Africa, Oceania, and the Caribbean, but these connections are not as dense in the case of GDP (PPP) per capita.

We should keep in mind that in the case of the high values node in Western Europe, for instance, we are dealing primarily with large volumes of services needed to service close economic ties, while the connections within the node of low values in Oceania is formed by their small populations with low population density and low economic development.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Bioethical freedom	0.047	0.009	0.203	0.877
2	Quality of school education	0.046	0.007	0.178	0.689
3	Infant mortality	0.025	0.039	-0.121	0.586
4	Internet users	0.036	0.014	0.143	0.568
5	Years at school	0.039	0.01	0.143	0.524
6	Young population	0.034	0.018	-0.129	0.489
7	Life expectancy	0.033	0.02	0.122	0.451
8	Specific number of researchers	0.046	0.025	0.143	0.445
9	Publication activity	0.046	0.005	0.14	0.426
10	Passport power	0.037	0.013	0.124	0.416

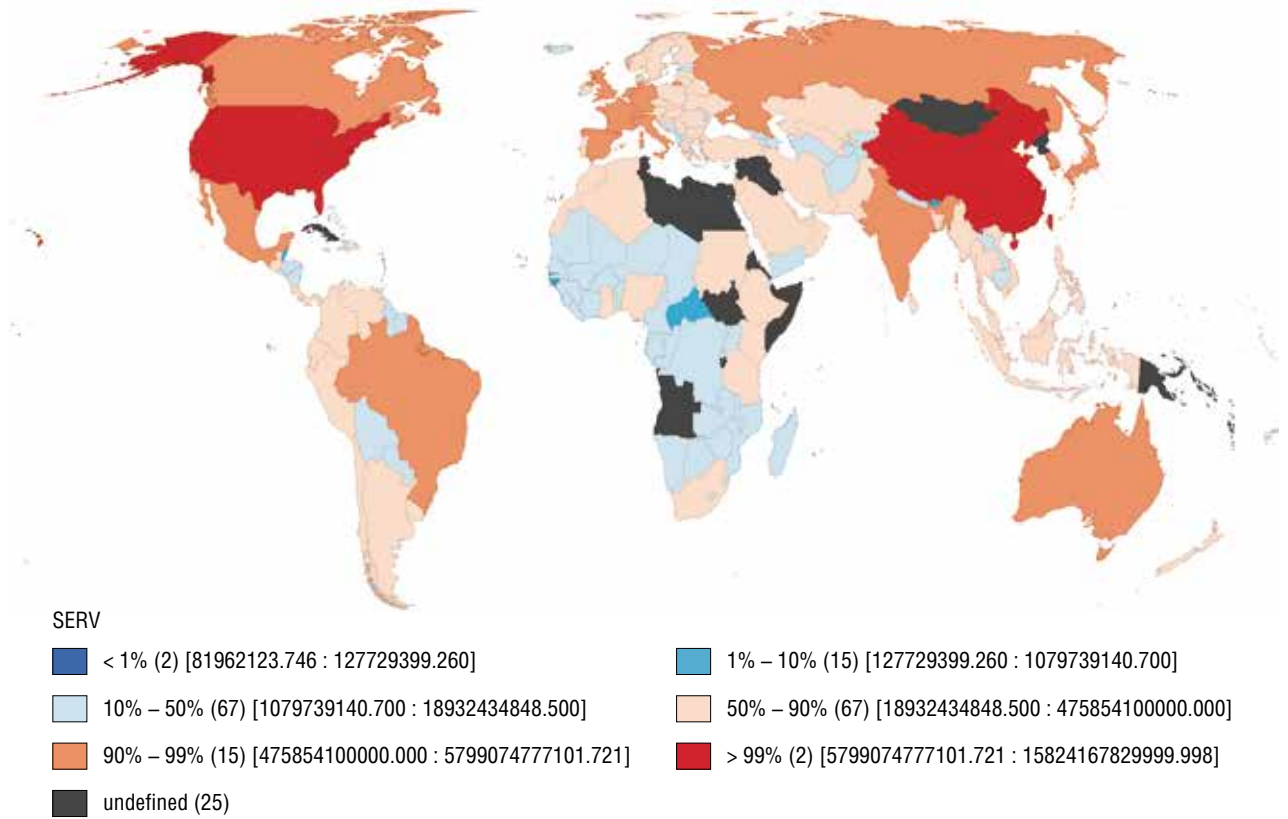


Fig. 3.6.1. Percentile cartogram for the “Services sector” indicator

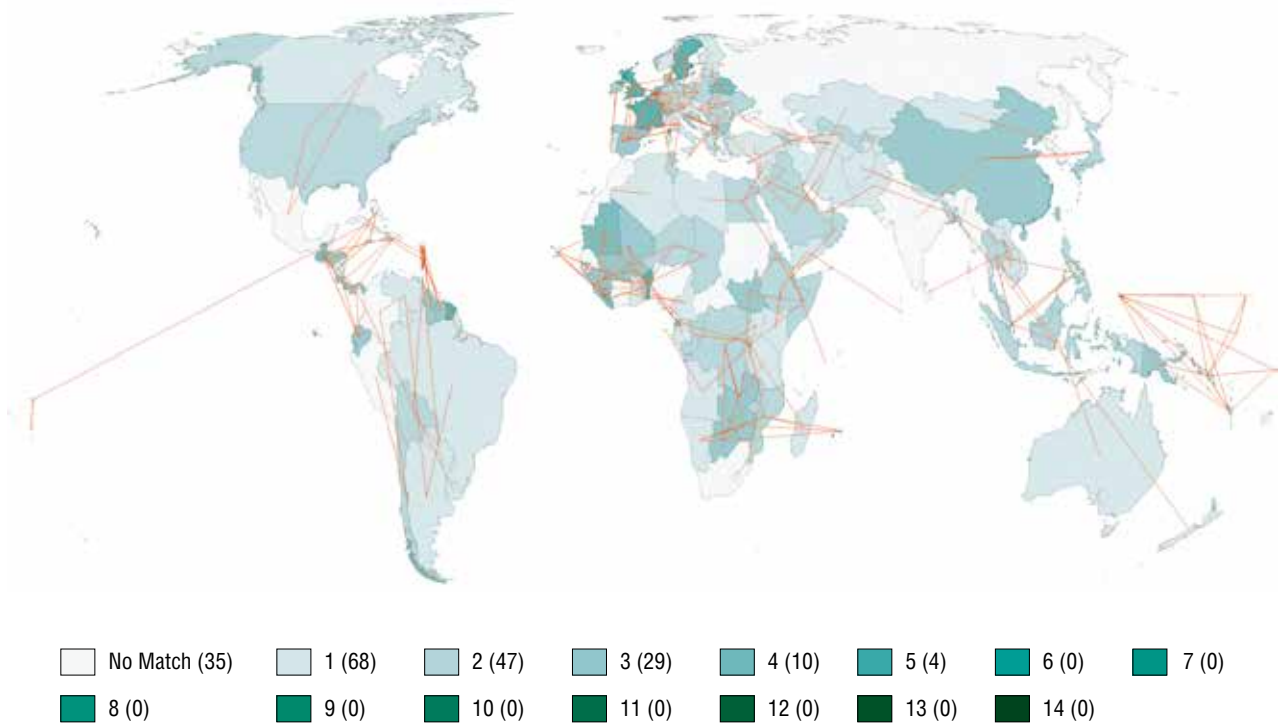


Fig. 3.6.2. Likelihood-ratio test for the “Services sector” parameter

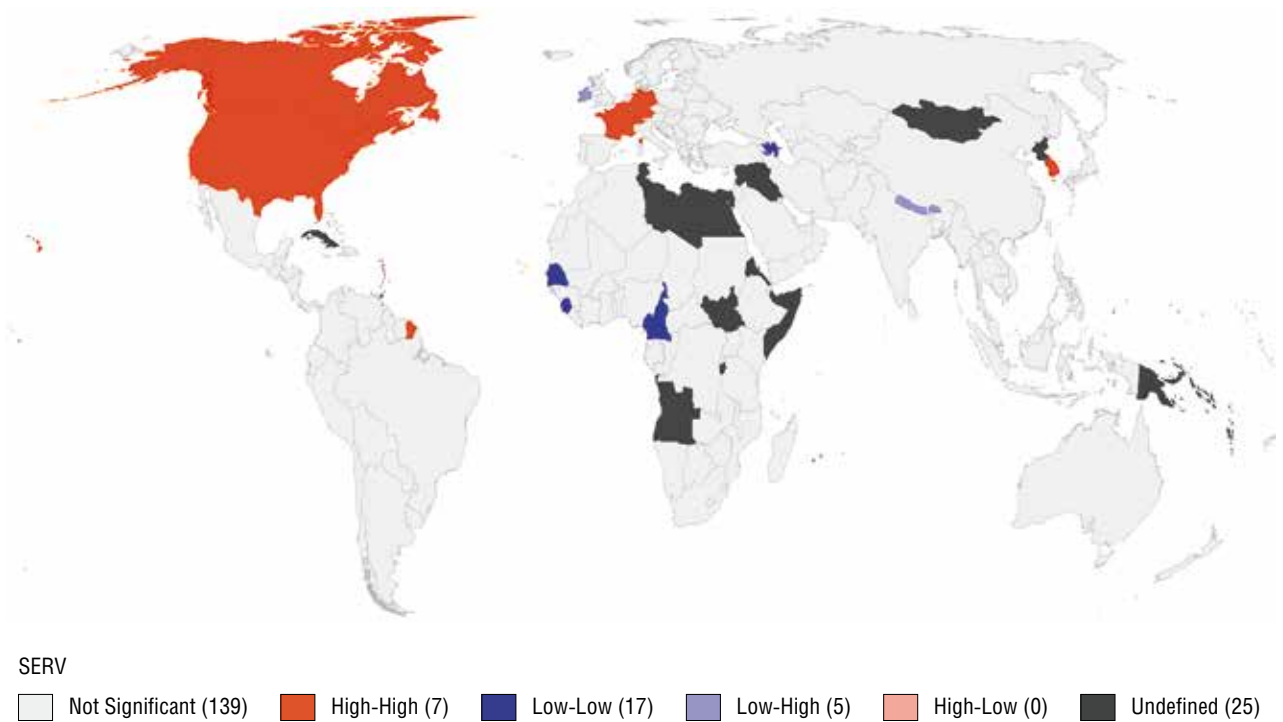


Fig. 3.6.3. “Services sector” spatial autocorrelation cartogram for the geometric neighbourhood matrix

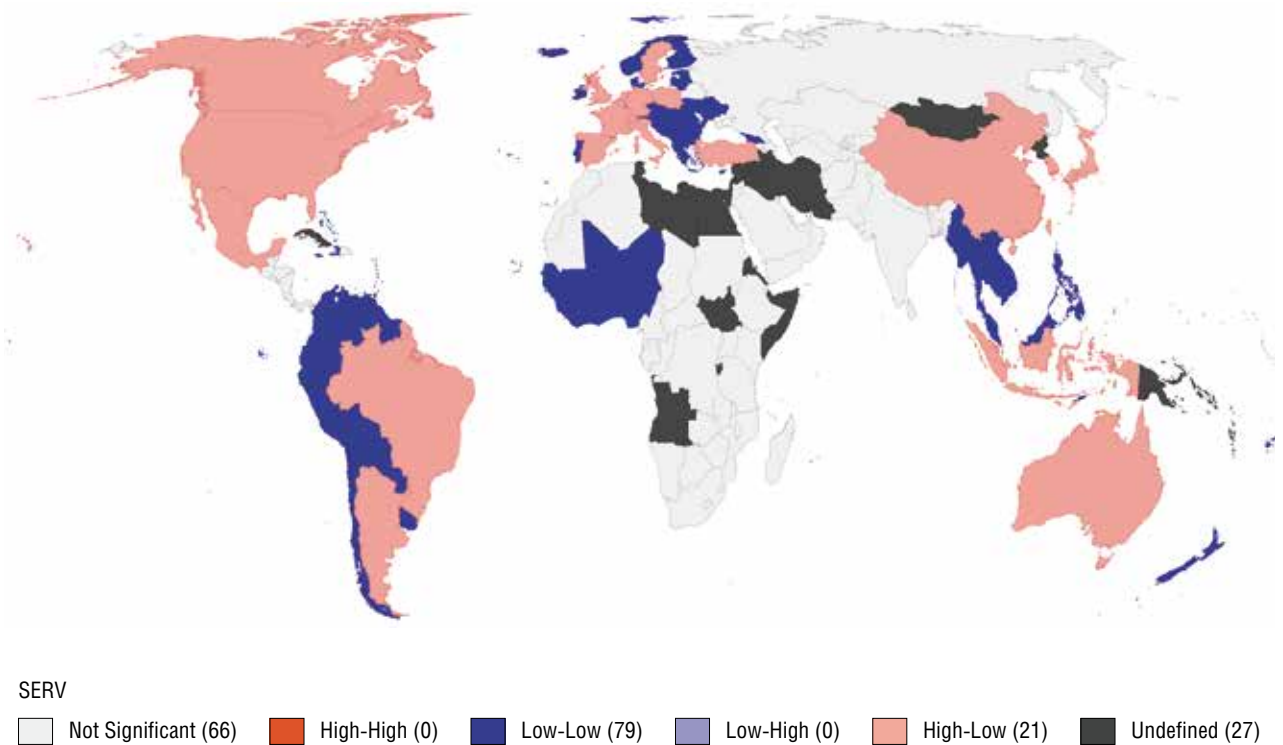


Fig. 3.6.4. “Services sector” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.7. Imports

Import volume is an important characteristic of a given state's involvement in global trade. For the purposes of our research, we represent the costs of imports of goods and services across countries in current dollars.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.185	0.000	0.101	0.000
Geary's C	1.067	0.730	0.894	0.000

The percentile cartogram (Fig. 3.7.1) shows that leaders in import volumes are large countries of the Northern hemisphere, primarily the United States and China, and also the countries of Western Europe, Japan, South Korea, India, Russia, Canada and Mexico. Low values are observed for African countries, Oceanic states, the poorer countries of Central Asia, the Caribbean and Latin America. Overall, the cartogram shows a provisional North–South divide.

We should note that even the smaller states of Western Europe have relatively high import levels due to their high quality of life and deep involvement in the EU economy. Characteristically, Hungary demonstrates mean global import indicator values, while the median value is seven times smaller and corresponds to the level of the Democratic Republic of the Congo. That is, imports in developed countries significantly outweigh the amount of imports that other states can afford.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.7.3) reveals six clusters: three high-value clusters (in North America, Western Europe and East Asia) and three low-value clusters (in the Eastern Caribbean, Western Africa and Oceania). Characteristically, high-value clusters include the most developed countries that are deeply involved in global economy. China likely did not make the East Asian cluster because it is surrounded by a number of countries with much smaller import volumes. Three low-value clusters are comprised of small and poor countries with little involvement in the global economy.

Global place	Country	Indicator (USD, million)
1	US	3,119,320
2	China	2,548,010
3	Germany	1,632,280
Mean (34)	(Hungary)	128,500 (127,516.91)
Median (90)	(Democratic Republic of the Congo)	17,770 (17,774.43)
177	Kiribati	170.52
178	Nauru	94.8
179	Tuvalu	39.5

There are exceptions in the Western European cluster. Countries with low imports here include Slovakia, Iceland and Luxembourg. Iceland is further removed from main trade flows and has a small population. Even though Luxembourg is located in the very heart of Europe, it is a micro-state that does not need large import volumes. Slovakia is in this cluster because it neighbours Poland, which has far greater import volumes compared to its Eastern European neighbours. This also represents a breach of the neighbourhood logic. Poland is characterized by a chronic trade balance deficit (with the exception of 2015–2017) because of active FDI and imports of investment goods.

The geopolitical neighbourhood matrix cartogram also features six clusters, but they have entirely different compositions. There is only one high-value cluster in East and Southeast Asia. Exceptions here are Laos, Cambodia, Myanmar and East Timor, which lag behind their neighbours in terms of economic development, as well as the small Brunei.

Next to it is an Oceanic cluster of low values that comprises mostly sparsely populated island states that are barely involved in international economic relations. Australia stands out against its neighbours, as it has unusually large exports, a highly developed economy and active foreign trade.

Four more low-value clusters are situated in West Africa, the east of the Caribbean, the northeast of Latin America, and the Euro-Atlantic. That latter has many “errors”: although it has more countries with relatively small import volumes (they are concentrated in Eastern Europe), it also has sufficient numbers of countries with large import volumes: Western European powers, the United States, Canada, and also Turkey.

Unlike the geometric neighbourhood matrix, the geopolitical neighbourhood matrix (Fig. 3.7.4) helped identify a cluster of high values in East and Southeast Asia. The cluster in West Africa expanded, and Euro-Atlantic countries are grouped in a cluster of low values with many exceptions.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Import” parameter (Fig. 3.7.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The test reveals a Western European node that reflects the deep economic integration of the core of the European Union. No other global region demonstrates such tight nodes, which is consistent with the outstripping development of European integration. The cartogram also reflects the high level of foreign trade ties in Southeast Asia. Several areas with similarly low import levels are emerging in Africa, namely, weak economies in sub-Saharan Africa.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Number of doctors	0.075	0	0.248	0.820
2	Suicide rate	0.036	0.017	0.171	0.812
3	Access to electricity	0.038	0.009	0.172	0.779
4	Bank deposits	0.036	0.018	0.166	0.765
5	Hospital beds	0.044	0.038	0.174	0.688
6	Regional trade agreements	0.087	0	0.239	0.657
7	Secondary education enrolment	0.053	0.003	0.183	0.632
8	Bioethical freedom	0.115	0	0.264	0.606
9	Quality of school education	0.136	0	0.283	0.589
10	Years at school	0.088	0	0.225	0.575

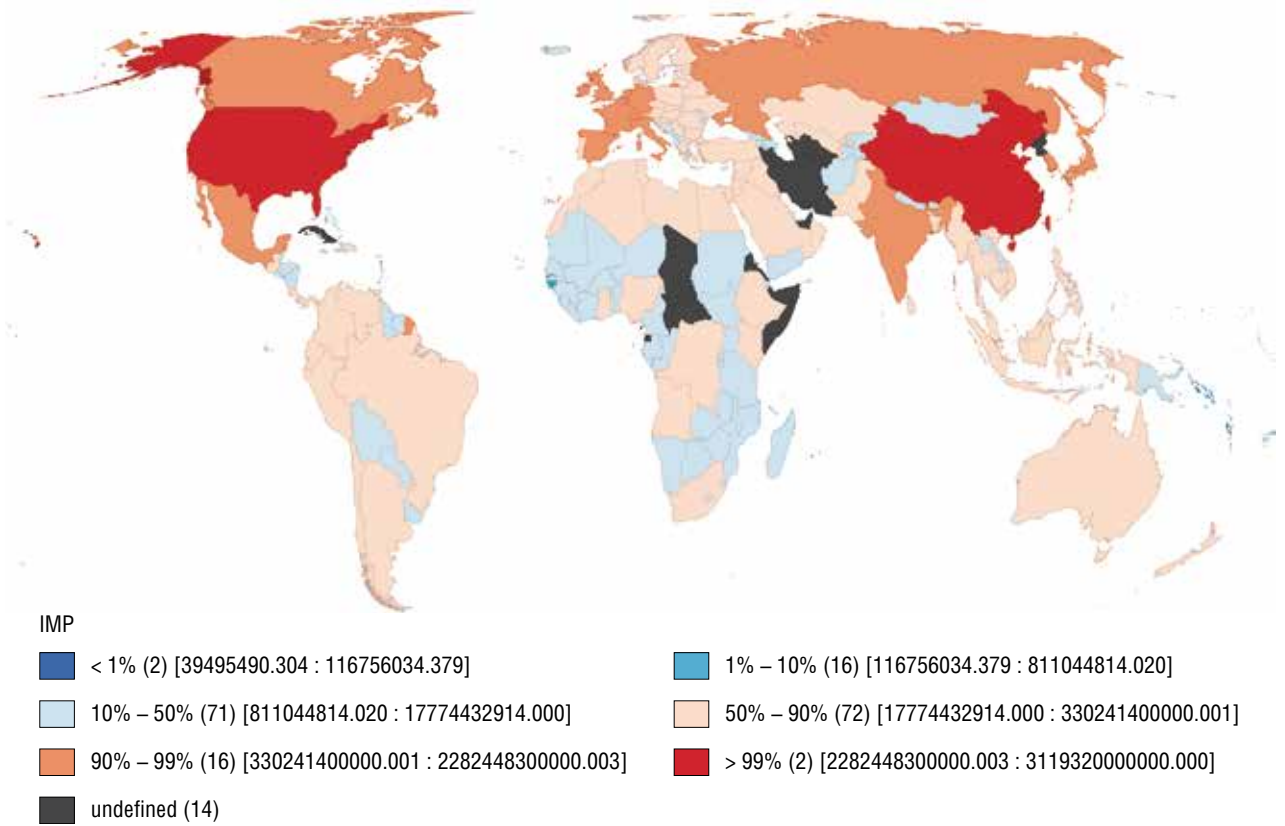


Fig. 3.7.1. Percentile cartogram for the “Imports” parameter

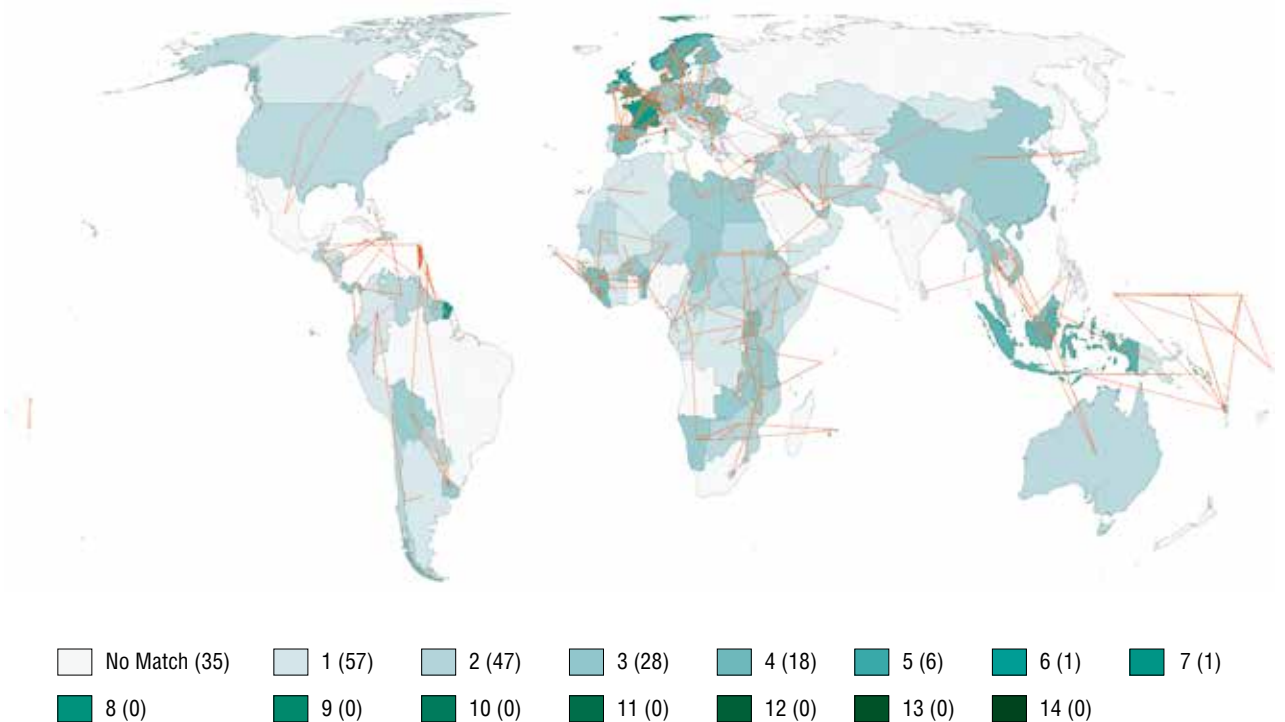


Fig. 3.7.2. Likelihood-ratio test for the “Imports” parameter

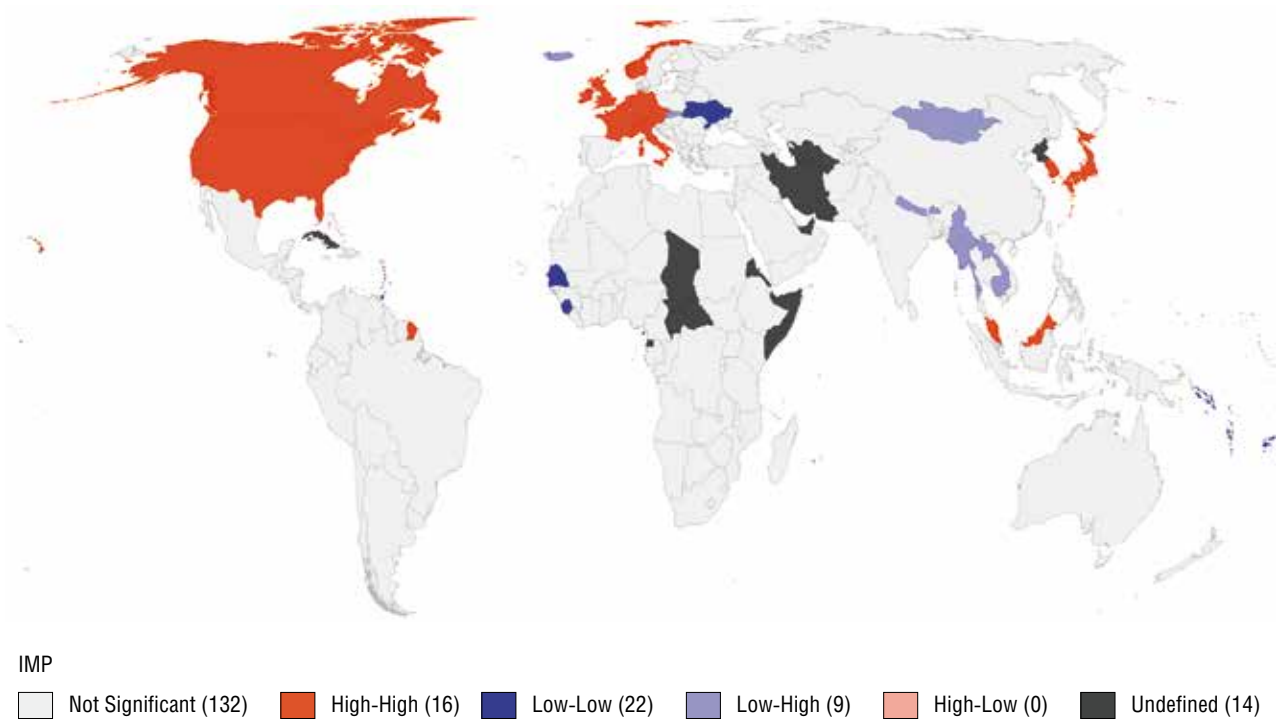


Fig. 3.7.3. “Imports” spatial autocorrelation cartogram for the geometric neighbourhood matrix

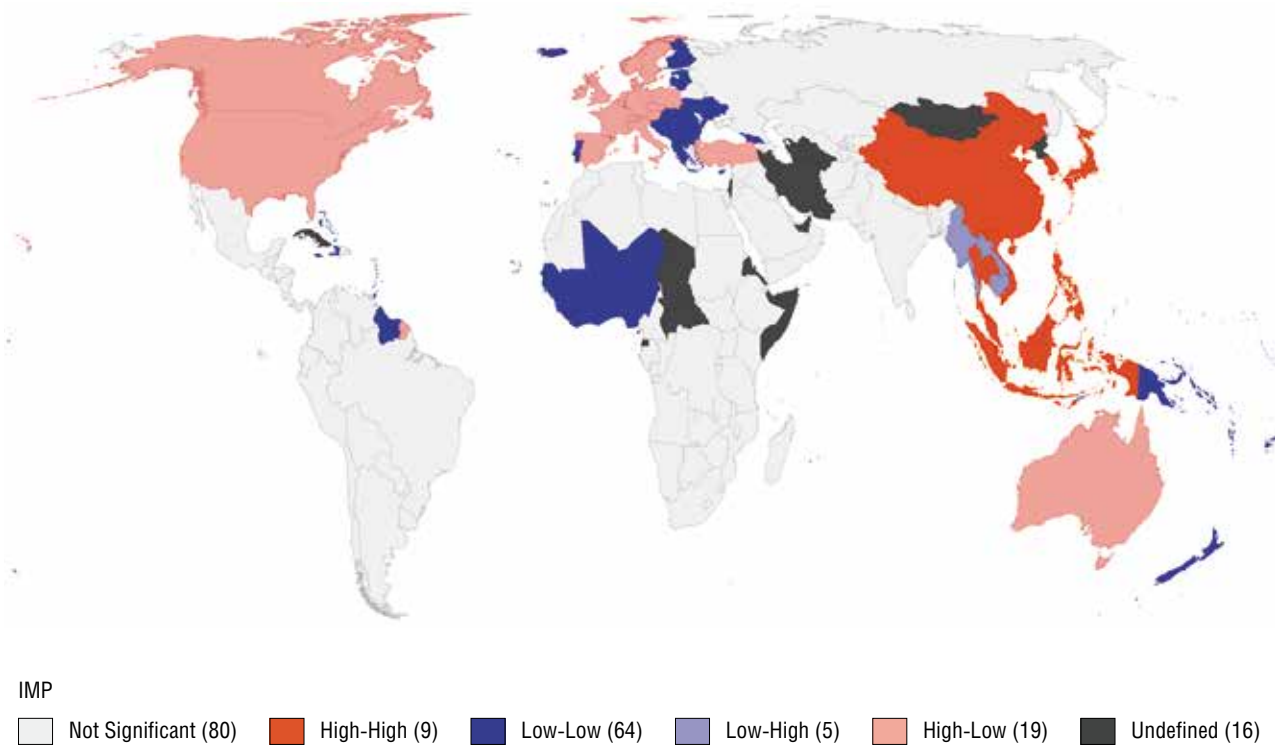


Fig. 3.7.4. “Imports” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.8. Exports

Exports are an important characteristic of a state's involvement in global trade. For the purposes of our research, we represent the costs of exports of goods and services across countries in current dollars.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.204	0.000	0.117	0.000
Geary's C	1.125	0.896	0.878	0.000

The percentile cartogram (Fig. 3.8.1) shows that countries with large exports are concentrated in the Northern hemisphere. As in the case of import, China, the United States and Germany form the trio of leaders, but this time, China is in first place. These countries have the largest and most developed economic systems, and their economic success is largely due to their key place in international trade.

Western European countries, Canada, Mexico, Japan, South Korea, India and Russia are all export leaders. Generally, this list resembles the list of import leaders. Curiously, minimum export and import volumes are observed in the same island states of Oceania: Nauru, Tuvalu and Kiribati, all of which have small populations, poorly developed economies, and are far removed from key foreign trade flows. Generally, the percentile cartogram reflects a notional division into North and South.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.8.3) shows five clusters. Three are high-value clusters: North American, Western European and East Asian. Russia has relatively high indicator value, but it is surrounded by Eastern European and Central Asian countries that export relatively small volumes of goods. Russia is also linked, as an exception country, to the East Asian cluster of high values that includes Japan and South Korea. Two low-value clusters comprise small island states in the east of the Caribbean and in Oceania.

Global place	Country	Indicator (USD, million)
1	China	2,651,010
2	US	2,539,380
3	Germany	1,877,500
Mean (34)	(Luxembourg)	131,900 (136,111)
Median (90)	(Paraguay)	14,250 (14,357.96)
178	Nauru	31.10
179	Tuvalu	20.58
180	Kiribati	19,150,922.8

The geopolitical neighbourhood matrix cartogram (Fig. 3.8.4) features seven spatial clusters. There is only one high-value cluster in East and Southeast Asia, and it includes the export leader, China, which did not make any cluster under the geometric neighbourhood matrix. Exceptions here are the Philippines, Laos, Cambodia, Myanmar and East Timor, which all lag behind their neighbours in terms of economic development, and the small nation of Brunei, whose economy depends on exports, although its size prevents the country from standing out on the map of exporting powers.

Two clusters in the Caribbean, a cluster in the northeast of Latin America and a cluster in West Africa, have low exports. Another low-value cluster is located in Oceania. The exception here is Australia, which has a large population and a developed economy, and is deeply involved in global trade. Another low-value cluster is located in the Euro-Atlantic region and includes more states with relatively small export volumes, while the global leaders (Western European countries, the United States and Canada) find themselves among the exceptions.

Therefore, the geopolitical neighbourhood matrix helped identify a developed export cluster involving China, but blurred the high-value cluster in Western Europe and North America. It also identified with greater clarity a low-value cluster in West Africa.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Export” parameter (Fig. 3.8.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. A dense network of countries in Western Europe reflects close economic ties within European integration. Another node of developed export ties is recorded in Southeast Asia. Africa, the Caribbean and Oceania once again feature low-value clusters, where neighbours, frequently small and/or economically underdeveloped states, have low export volumes.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Pharmaceutical exports	0.036	0.021	0.194	1.045
2	Number of doctors	0.09	0	0.266	0.786
3	Bank deposits	0.043	0.009	0.183	0.779
4	Access to electricity	0.044	0.004	0.184	0.769
5	Regional trade agreements	0.106	0	0.267	0.673
6	Suicide rate	0.042	0.01	0.168	0.672
7	Maternal mortality	0.048	0.004	-0.175	0.638
8	Railway network	0.074	0.002	0.213	0.613
9	Secondary education enrolment	0.065	0.001	0.199	0.609
10	Bioethical freedom	0.124	0	0.274	0.605

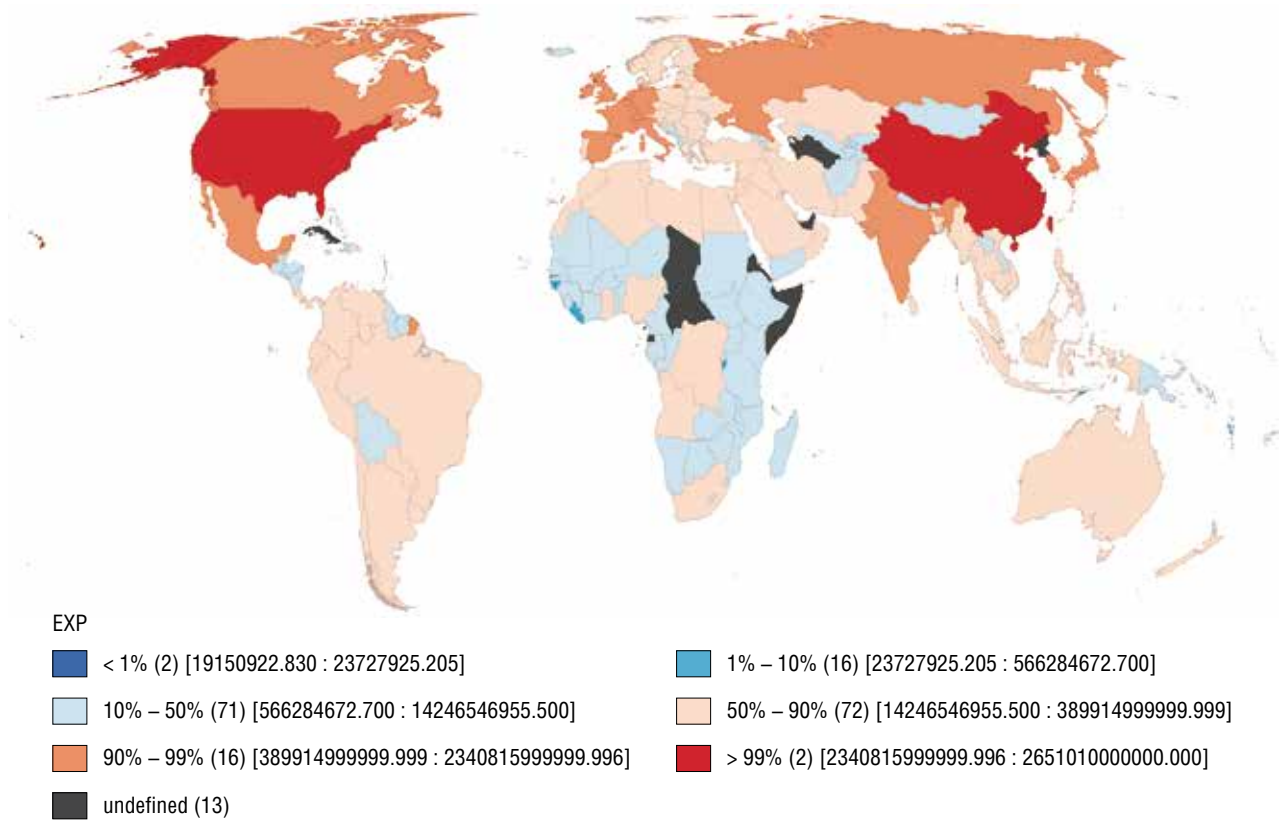


Fig. 3.8.1. Percentile cartogram for the “Exports” indicator

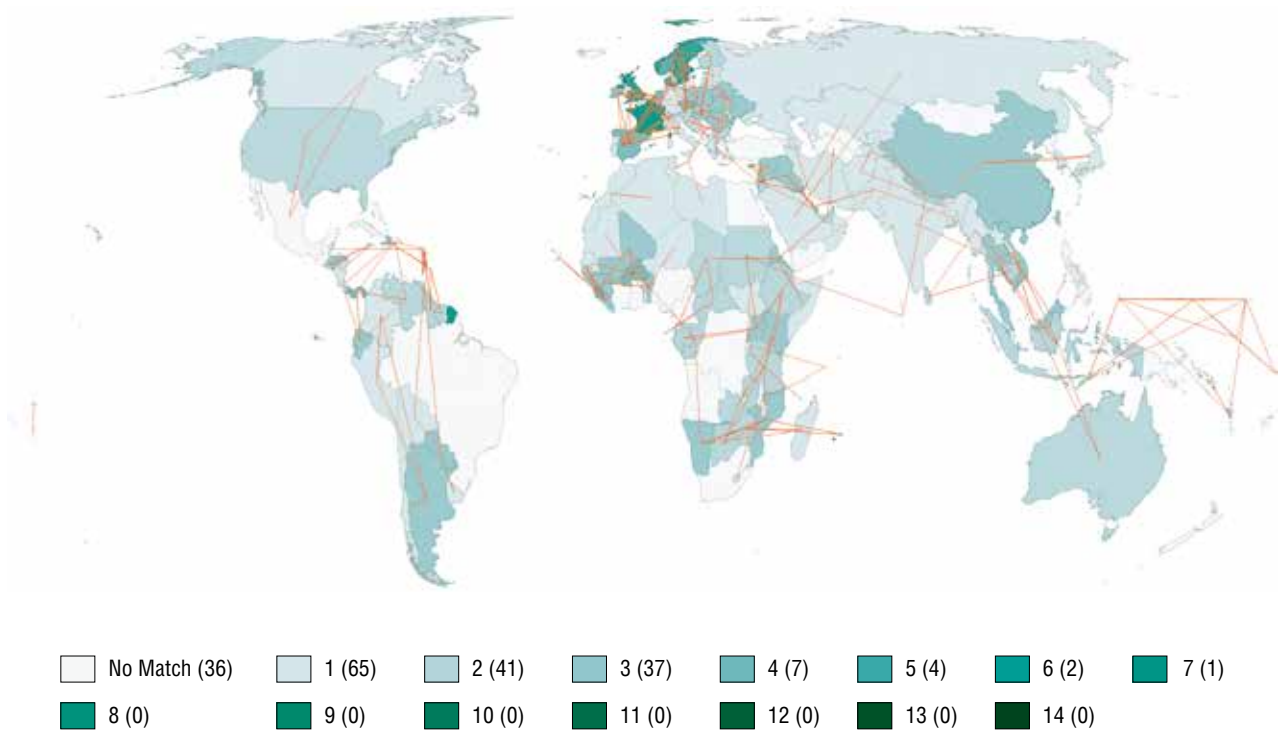


Fig. 3.8.2. Likelihood-ratio test for the “Exports” parameter

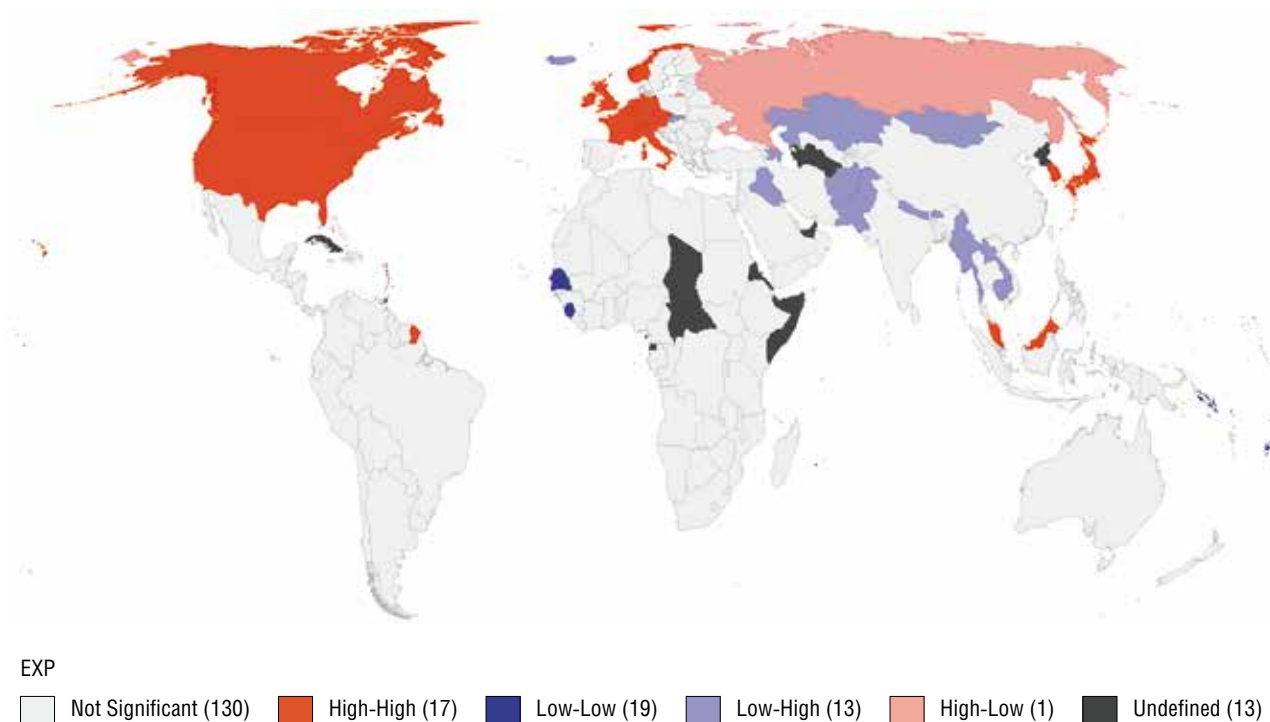


Fig. 3.8.3. “Exports” spatial autocorrelation cartogram for the geometric neighbourhood matrix

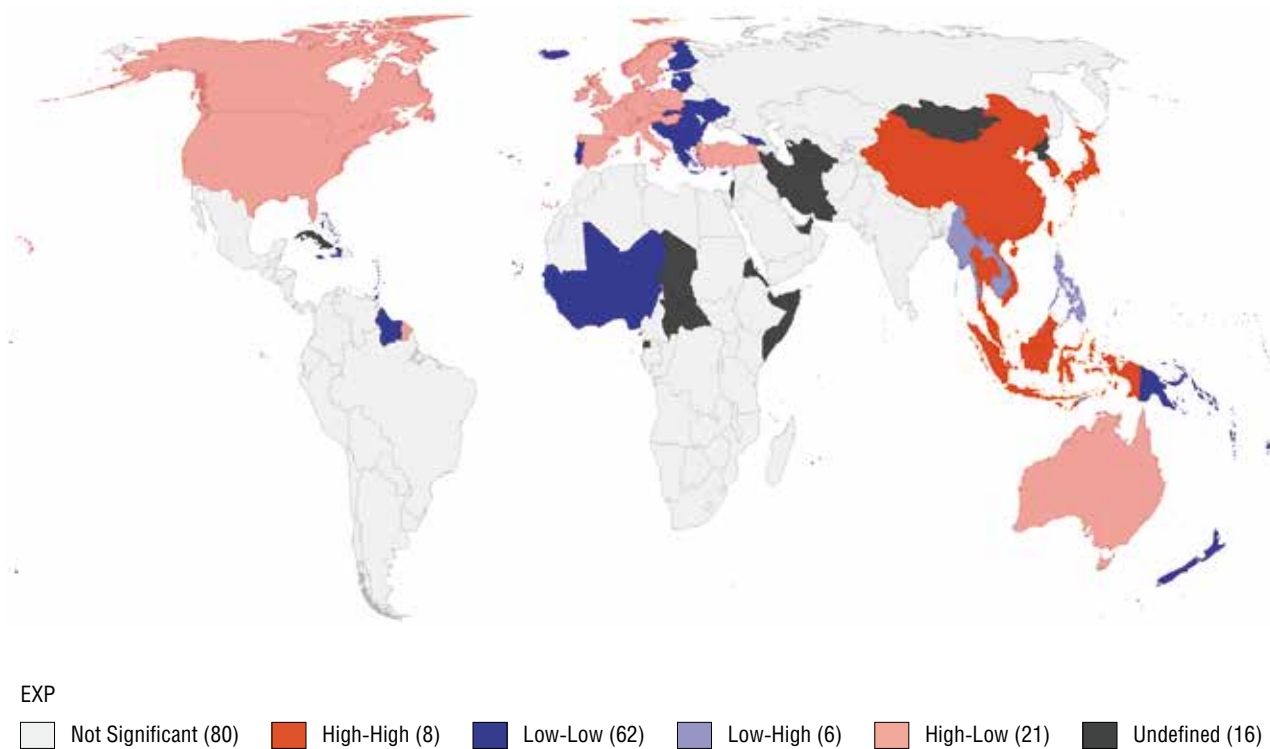


Fig. 3.8.4. “Exports” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.9. Unused export potential

Unused export potential is calculated in terms of supply and demand for exported products, adjusted for the ease of mutual trade. This indicator helps assess the prospects of developing a particular economy by building up export-oriented sectors.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.159	0.000	0.140	0.000
Geary's C	1.484	0.999	0.855	0.000

The percentile cartogram (Fig. 3.9.1) shows that countries with the highest unused export potential are concentrated in Western Europe, North America and East and Southeast Asia. The leading states in this metric are also global export powerhouses: China, Germany and the United States. Countries with the lowest unused export potential are mostly located in Africa, the world's poorest region. Among the other countries in this category are small island states in the Caribbean and Oceania. These regions do not boast highly profitable export sectors, and there are no resources for rapidly building them up.

The gap in unused export potential is even greater than the gap in exports: the mean is 16 times greater than the median, i.e. developed countries are in a much better position to build up their exports even further and bolster their global economic standing than other states.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.9.3) features four clusters. Two include countries with high unused export potential: in Western Europe and in Southeast Asia. These are countries with developed economies that are deeply involved in international trade. Exceptions here are small states: Luxembourg, Iceland, and Slovenia, and also Ukraine, whose economy has been undermined by an armed conflict. Brunei constitutes an "error" in the Southeast Asian cluster: even though its economy depends entirely on exports of oil and gas, it is a small country and, consequently, it does not have extensive potential for building up its exports. Low-value clusters in Oceania and in the east of the Caribbean comprise small island states with small populations and undeveloped economies.

Global place	Country	Indicator (USD, million)
1	China	1,400,000
2	Germany	589,900
3	US	586,900
Mean (35)	(Denmark)	40,270 (44,900)
Median (94–95)	Mozambique, Ethiopia	2,500
187	Nauru	2.9
188	South Sudan	2.2
189	São Tomé and Príncipe	1

The geopolitical neighbourhood matrix cartogram (Fig. 3.9.4) features seven spatial clusters. There is only one high-value cluster in East and Southeast Asia and includes, among other countries, the world leader (China). “Errors” here are Myanmar, Laos, Cambodia and East Timor, all of which are less developed than their respective neighbours, as well as Brunei, which is rich in oil and gas, but small in size.

Low-value clusters in the Caribbean and the northeast of Latin America comprise small, sparsely populated, mostly island states that do not have large resources for economic development. More populous states of West Africa that also constitute a low-value cluster have very poorly developed economies. Another low-value cluster is identified in Oceania, a locus of island states that are poorly developed economically and weakly involved in global trade. The exception here is large and highly developed Australia, which is integrated into western economic ties.

Another atypical low-value cluster is located in the Euro-Atlantic region. In terms of numbers, it is dominated by countries whose economies are not particularly well developed. This group includes Eastern European and Balkan states, Portugal, Iceland and some northern countries, which “set the tone” for the entire cluster. Meanwhile, the leaders in unused export potential — Western European countries, the United States, Canada and Turkey — stand out as “errors.”

Therefore, the geopolitical matrix did identify a high-value cluster around the world leader, China, and in West Africa, but it also transformed the Euro-Atlantic cluster.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Unused export potential” parameter (Fig. 3.9.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. Western European countries stand out in terms of their unused export potential: deep integration allows them to not only occupy a key place in the current structure of international trade, but also to build up their export volumes in the future. Another node with high indicator values is observed in Southeast Asia. These countries have already received a major development boost due to their deep involvement in global trade, but also have the potential to develop their export capabilities.

In West and Central Africa, there are countries that both share a geographic location and exhibit low levels of unused export potential: their undeveloped economies and rampant poverty will prevent them from building up exports in any significant manner in the future.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Hospital beds	0.041	0.039	0.211	1.086
2	Bank deposits	0.024	0.05	0.148	0.913
3	Number of doctors	0.038	0.007	0.183	0.881
4	Railway network	0.04	0.023	0.167	0.697
5	Secondary education enrolment	0.034	0.018	0.143	0.601
6	Specific number of researchers	0.086	0.001	0.227	0.599
7	Years at school	0.049	0.003	0.166	0.562
8	Bioethical freedom	0.076	0	0.206	0.558
9	Maternal mortality	0.033	0.015	−0.133	0.536
10	Quality of school education	0.105	0	0.234	0.521

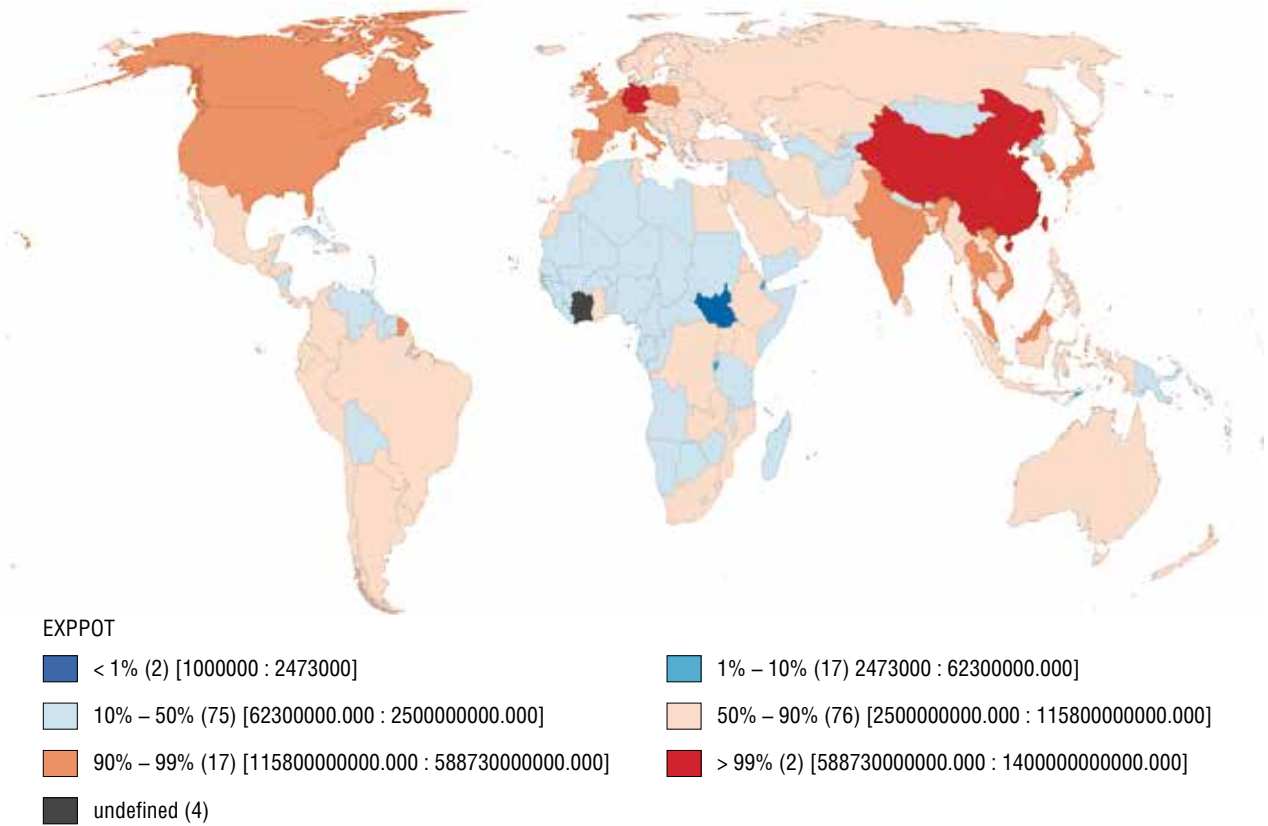


Fig. 3.9.1. Percentile cartogram for the “Unused export potential” indicator

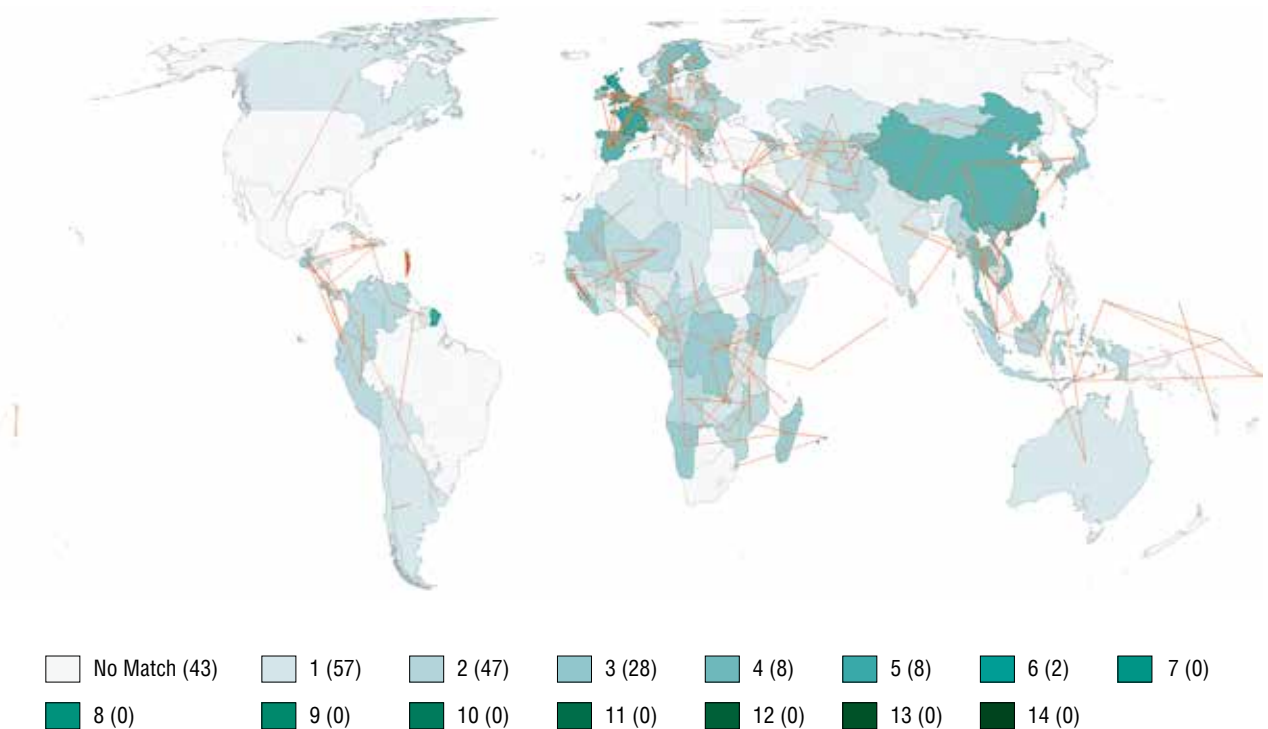


Fig. 3.9.2. Likelihood-ratio test for the “Unused export potential” parameter

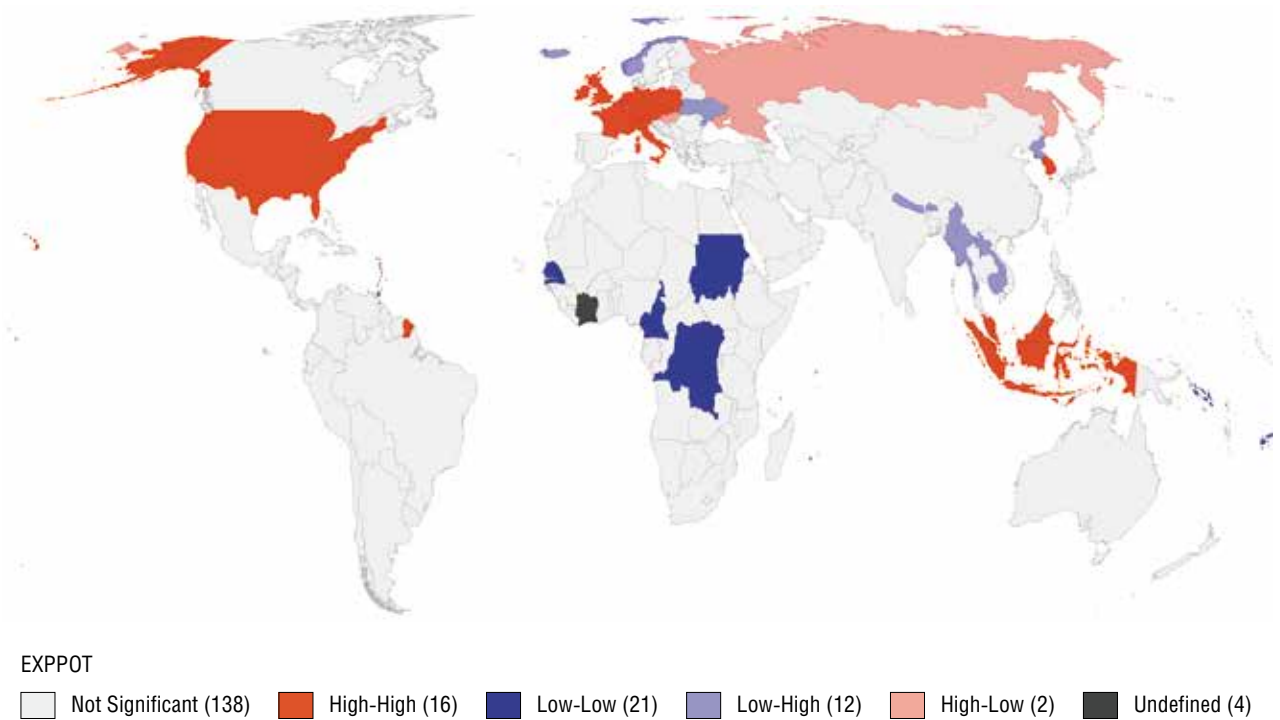


Fig. 3.9.3. “Unused export potential” spatial autocorrelation cartogram for the geometric neighbourhood matrix

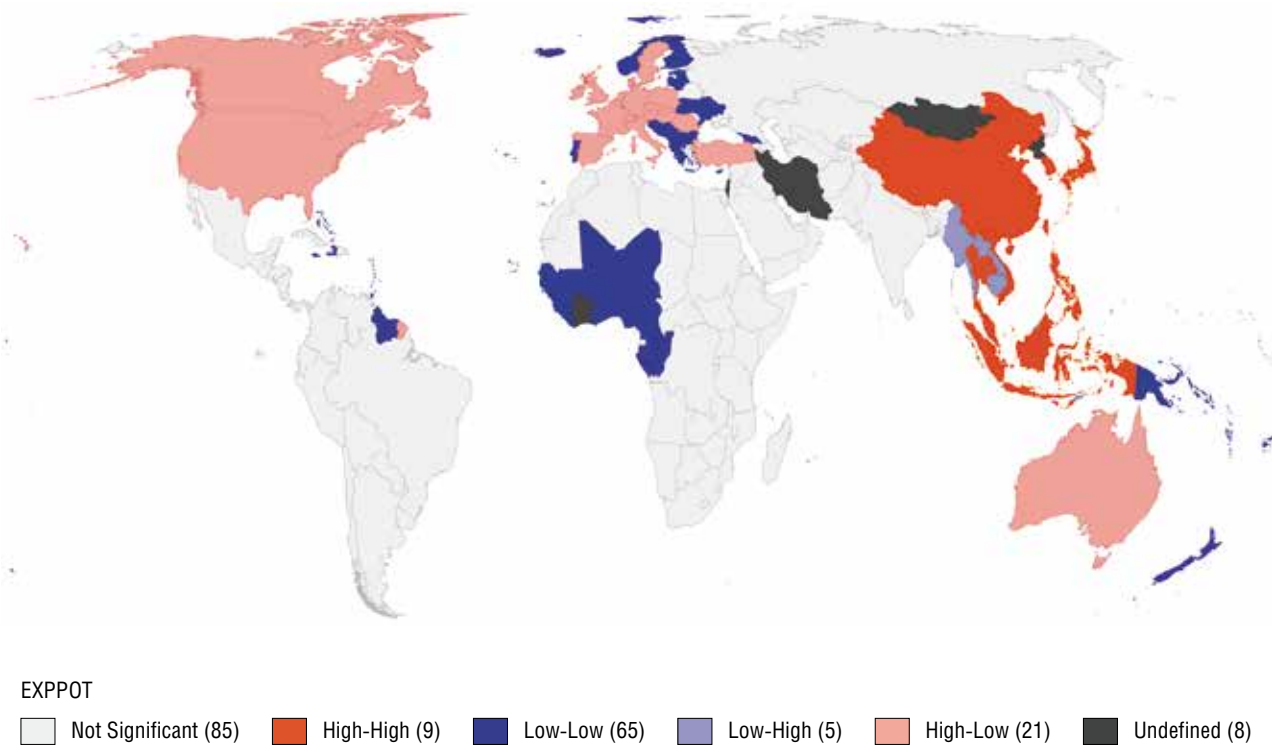


Fig. 3.9.4. “Unused export potential” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.10. Regional trade agreements

Active involvement in global trade allows countries to attract goods and resources they lack, thereby improving their quality of life. One instrument for creating more favourable trade conditions is involvement in regional trade agreements (RTA). This is where two or more countries agree on preferential trade terms and favourable tariff conditions.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.668	0.000	0.596	0.000
Geary's C	0.324	0.000	0.402	0.000

The percentile cartogram (Fig. 3.10.1) shows that states with the highest numbers of RTAs are located in Europe, and they are all members of the European Union — the world's largest economic bloc that enjoys a strong bargaining position and developed culture of negotiating. The European Union represents 40% of global exports and imports in goods (not including domestic trade) and is deeply integrated into the global economy. It thus has a vested interest in liberalizing trade, protecting investments and aligning technological standards, which it achieves by concluding various trade agreements. Notably, the European Union's trade policy falls under the exclusive purview of the community bodies in charge of regulating foreign trade and investment and concluding trade and investment agreements.

India and China both exhibit high values of this indicator, as do rapidly developing states that are interested in simplified access to markets, and developed states of East Asia and countries on the Pacific coast of South America.

Low values are typical for the overwhelming majority of African states. Most African states have two to three RTAs at best. This may be due to Africa's extremely low share in global trade and capital flow (the continent's share in global exports is below 3%, with South Africa accounting for 0.5%), its poorly diversified foreign trade and, consequently, the low complementarity of domestic markets (the share of intra-regional trade is insignificant).

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 3.10.3) identifies a large cluster of high value countries located in Europe. In addition to most EU states, this cluster includes

Global place	Country	Indicator (quantity)
1–27	27 countries	45
28	Iceland	32
29	Norway, Switzerland	31
Mean (137–139)	(Honduras, New Zealand, El Salvador)	11.7853 (12)
Median (83–96)	(14 countries)	4 (4)
132–164	33 countries	2
165–185	21 countries	1
186–191	Mauritania, Djibouti, Palau, South Sudan, São Tomé and Príncipe, Somalia	0

the United Kingdom, Ukraine and Norway. Russia did not make the cluster since its RTAs are confined to agreements within the Eurasian Economic Union (EAEU) and the CIS and to a handful of nearby states.

A small low-value cluster is located in West Africa, and a large cluster is located in East Africa.

The geopolitical neighbourhood matrix cartogram (Fig. 3.10.4) demonstrates certain differences. For instance, a large trans-Atlantic cluster with high values emerged. We should note that the United States and the European Union are the largest trade partners of most countries in the world and two large poles of global trade. On the one hand, high manufacturing levels dictate the need for easier access to foreign markets, while, on the other hand, the competitive edge of goods manufactured in the United States or Europe allows them to open up their own markets without endangering domestic economies.

Additionally, we should emphasize the role of RTAs as a mechanism for creating “multilateral frameworks.” Given their political and economic power, countries of the “collective West” strive to establish certain international norms and standards by involving the largest possible number of countries in an interconnected system of international trade agreements. Hence the trend for expanding the areas regulated by RTAs, which is advantageous for Western countries (so-called “new generation” RTAs).

A different low-value cluster also emerged in West Africa that includes West African Economic and Monetary Union (UEMOA) and Economic Community of West African States (ECOWAS) members.

In East and Southeast Asia, there is a gap between the leaders (China, Thailand, Australia, New Zealand) and the majority of ASEAN member states. China is the unquestionable leader in the region leader in terms of export volumes. Beijing is interested in concluding RTAs in order to advance its economic interests. Additionally, China is interested in building a regional trade system that does not involve the United States. That said, its indicator value is far lower than that of European countries and stands out as an “error” only because China neighbours states that have fewer than 10 RTAs.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Regional trade agreements” parameter (Fig. 3.10.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram clearly shows a large European “node” which attests to close trade ties between European countries. Several clusters of sub-Saharan countries are observed in Africa which are barely involved in the international system of trade agreements.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Population growth	0.167	0	-0.416	1.036
2	Women in politics	0.08	0	0.277	0.959
3	IMF voting power	0.054	0.001	0.277	0.954
4	Female population	0.042	0.006	0.194	0.896
5	Export	0.106	0	0.301	0.855
6	Economic inequality	0.155	0	-0.363	0.85
7	Access to electricity	0.150	0	0.356	0.845
8	Number of doctors	0.374	0	0.553	0.818
9	Maternal mortality	0.174	0	-0.374	0.804
10	Infant mortality	0.272	0	-0.467	0.802

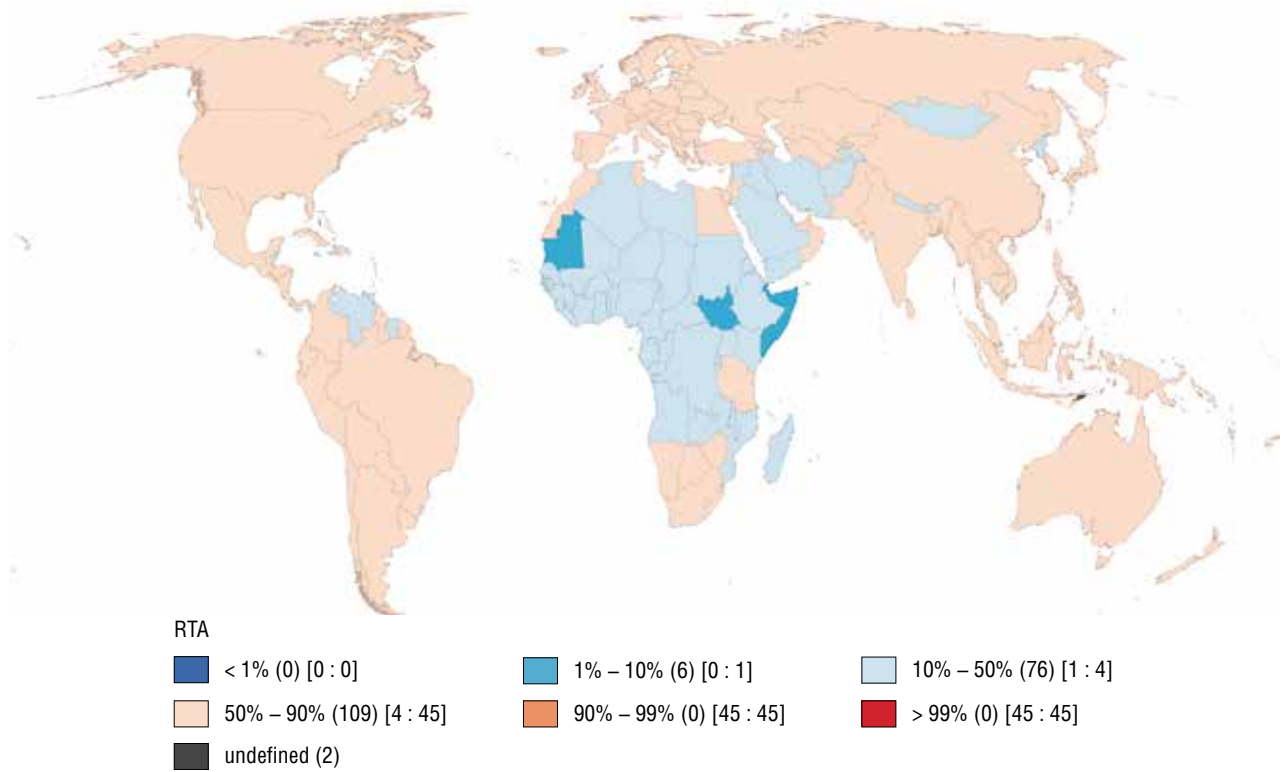


Fig. 3.10.1. Percentile cartogram for the “Regional trade agreements” indicator

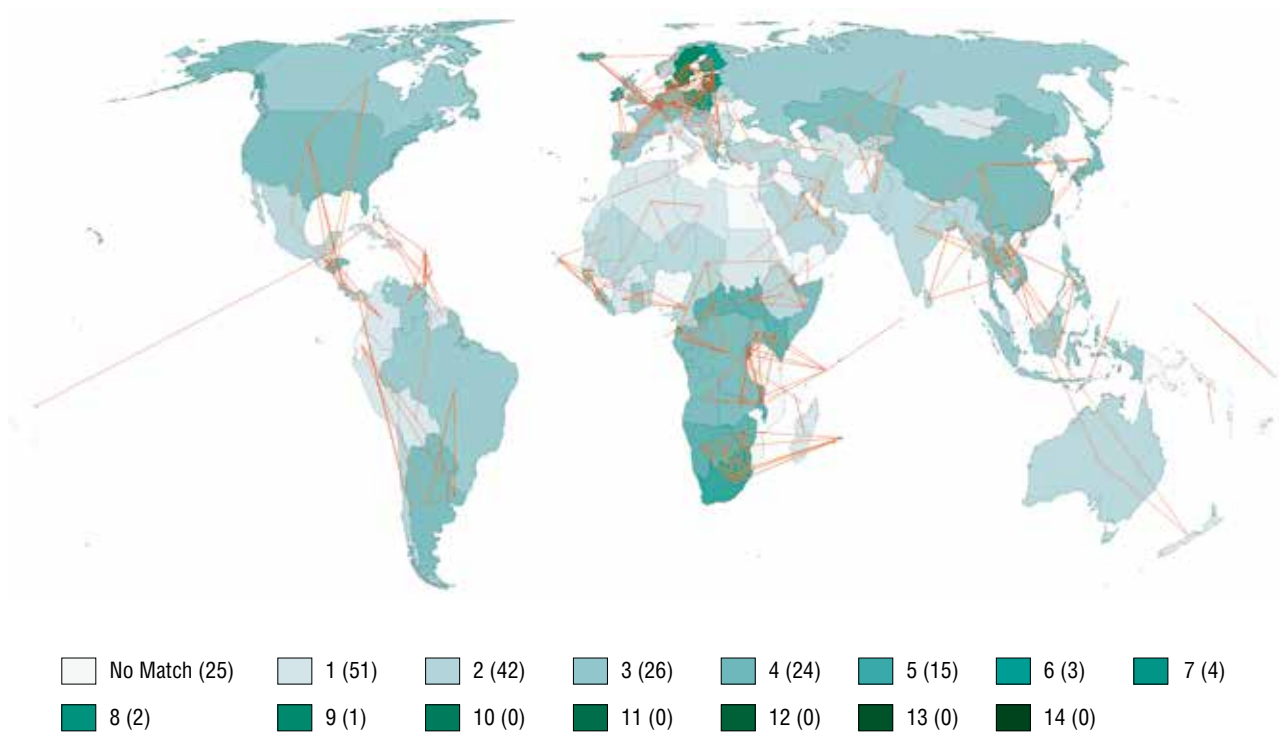


Fig. 3.10.2. Likelihood-ratio test for the “Regional trade agreements” parameter

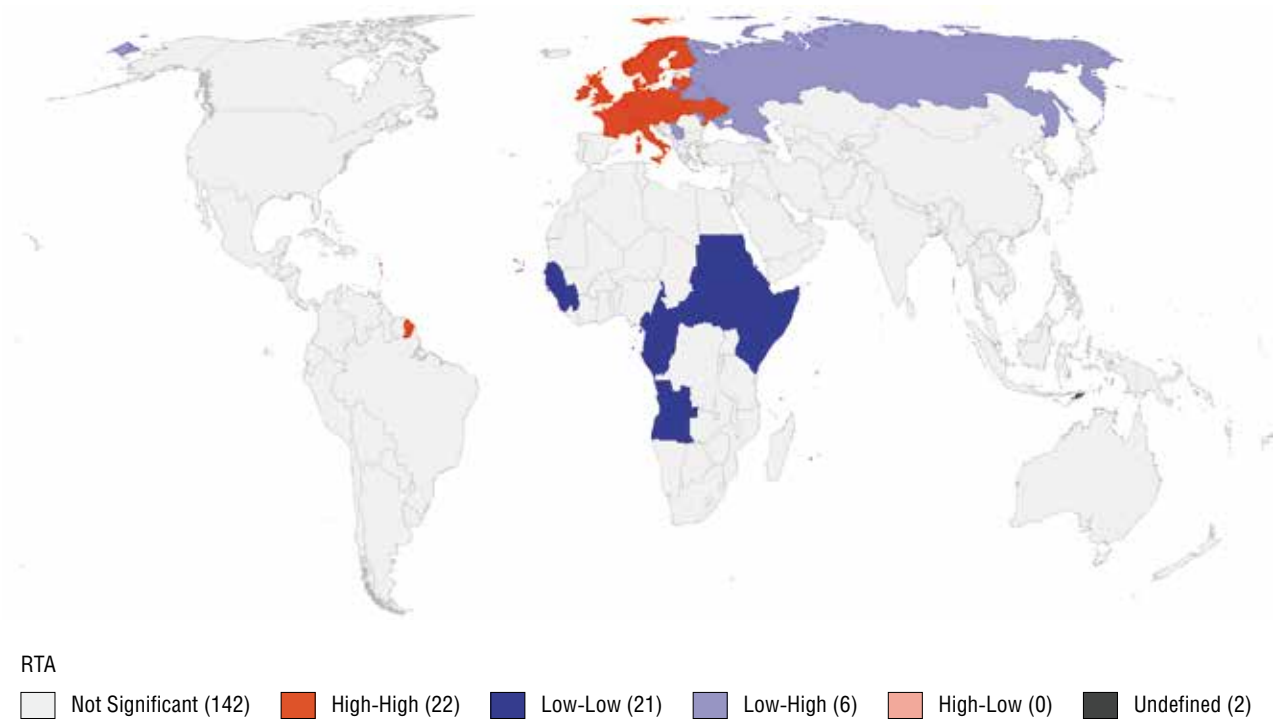


Fig. 3.10.3. “Regional trade agreements” spatial autocorrelation cartogram for the geometric neighbourhood matrix

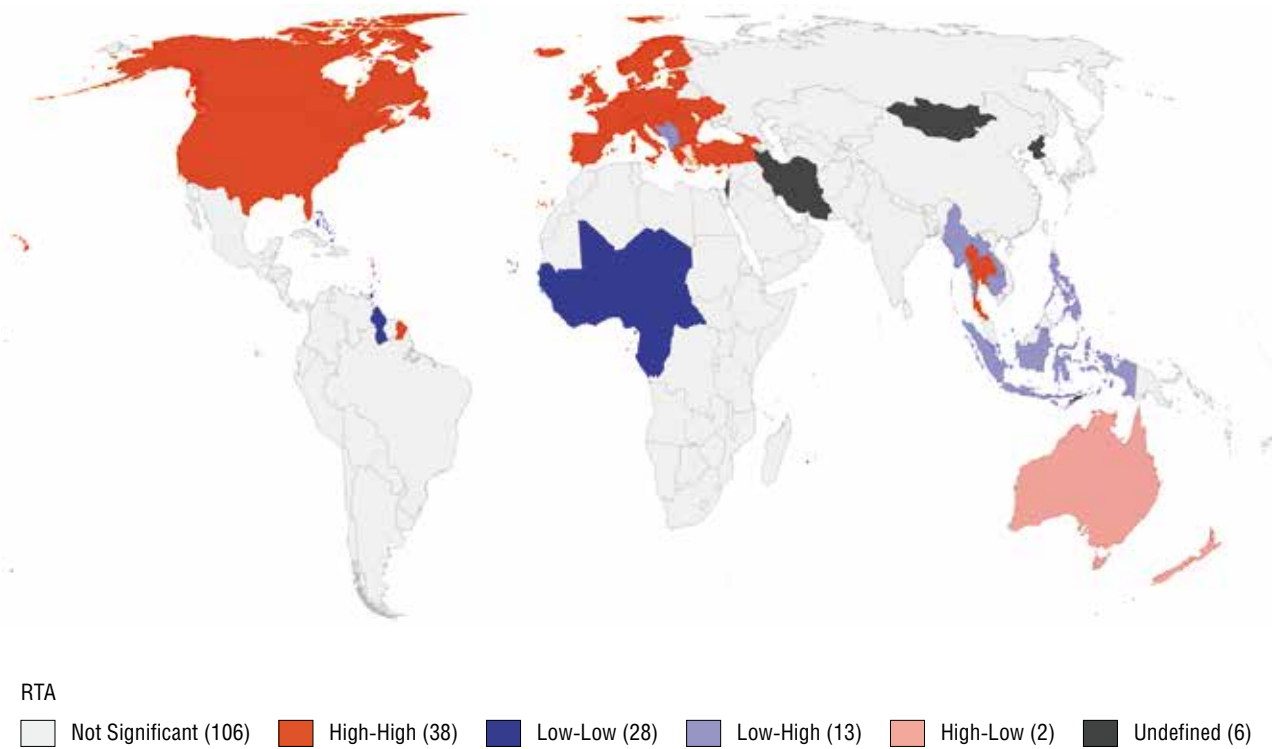


Fig. 3.10.4. “Regional trade agreements” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

3.11. Multifactor analysis of the “Economy” section indicators

The next research stage involves a multifactor analysis of the indicators described above. It includes analysis of the geographic average, multifactor Geary's C, inverse spatial cluster analysis, and multidimensional scaling.

Out of all the “Economy” section indicators, the greatest difference in geographic averages is exhibited by the rate of gross accumulation, services sector, and unused export potential.

The geographic average of the rate of gross accumulated is skewed southward compared to the same point for other two indicators, which may be explained by many developing countries in Africa and Asia having rather high indicator values. The geographic ellipse average for the rate of gross accumulation has the least elongated shape because of the indicator's small spread among different countries.

Compared to the rate of gross accumulation, the geographic averages for both the services sector and unused export potential are rather skewed northward because countries of the Northern hemisphere, home to the undisputed leaders, the United States and China, demonstrate far greater values of these indicators. However, the geographic average for the services sector is located far more westerly than the geographic average for export potential, since, compared to the developing countries of Asia, Africa and Latin America, the countries of the collective West, particularly the United States, demonstrate far higher values for this indicator. The geographic average for the unused export potential is skewed westward because of China's extremely high values for this indicator.

Considering geographic average ellipses by geopolitical group, we can observe significant differences in the spatial distribution of industry and agriculture. For instance, in Europe and in North America, the industrial production ellipse is skewed towards the northwest, since this area is developed far more in the countries of Western Europe and particularly in the United States compared to the south and east of Europe. This distribution is more even for the agriculture indicator. Russia is the point of attraction for post-Soviet states, significantly outstripping all countries of the group in this indicator. However, the agriculture ellipse is somewhat more skewed towards the southwest, which reflects the smaller gap between countries in the south of the region and Russia. In East and Southeast Asia, the geographic average ellipse for agriculture is stretched southward to a greater degree than the industry ellipse. In both cases, China's high indicator values are of key significance for the geographic average, yet the developed industrial production in Japan and South Korea pushes the ellipse northward and gives it a rounder shape. A significant divergence is observed in the Middle East and North Africa: the industry ellipse is skewed towards the Arabian Peninsula, a regional and global oil production leader. A far smaller industry ellipse in Australia and Oceania demonstrates that industry dominates agriculture in the region.

The cartograms for multifactor Geary's C identify groups of neighbouring countries that are most similar and dissimilar to their neighbours in terms of the ten economic section indicators.

The geometric neighbourhood matrix (Fig. 3.11.1) helps identify six such clusters. Four are clusters of countries that are similar to their neighbours, which creates prerequisites for regional economic integration. These are a European cluster, a South American, a Central African and an East Asian cluster. Two more clusters comprise the countries that are most dissimilar to their neighbours: one cluster comprises Russia, Kazakhstan, Kyrgyzstan, Tajikistan and Afghanistan, while the other spans Vietnam, Laos and Myanmar. Accordingly, economic integration in these countries may rely rather on the complementarity of economic systems than on their similarities.

The geopolitical neighbourhood matrix (Fig. 3.11.2) creates a different picture: now there are five clusters. Four of them emerge on the geometric neighbourhood matrix cartogram. However, under the geopolitical neighbourhood matrix, the Euro-Atlantic cluster of countries that are similar to their neighbours also includes the United States, since the similarity between the United States and its neighbours has become more significant within the tighter-knit group of western countries. Compared to the geometric neighbourhood matrix, the Latin American cluster has expanded to include Mexico, Paraguay and Central American

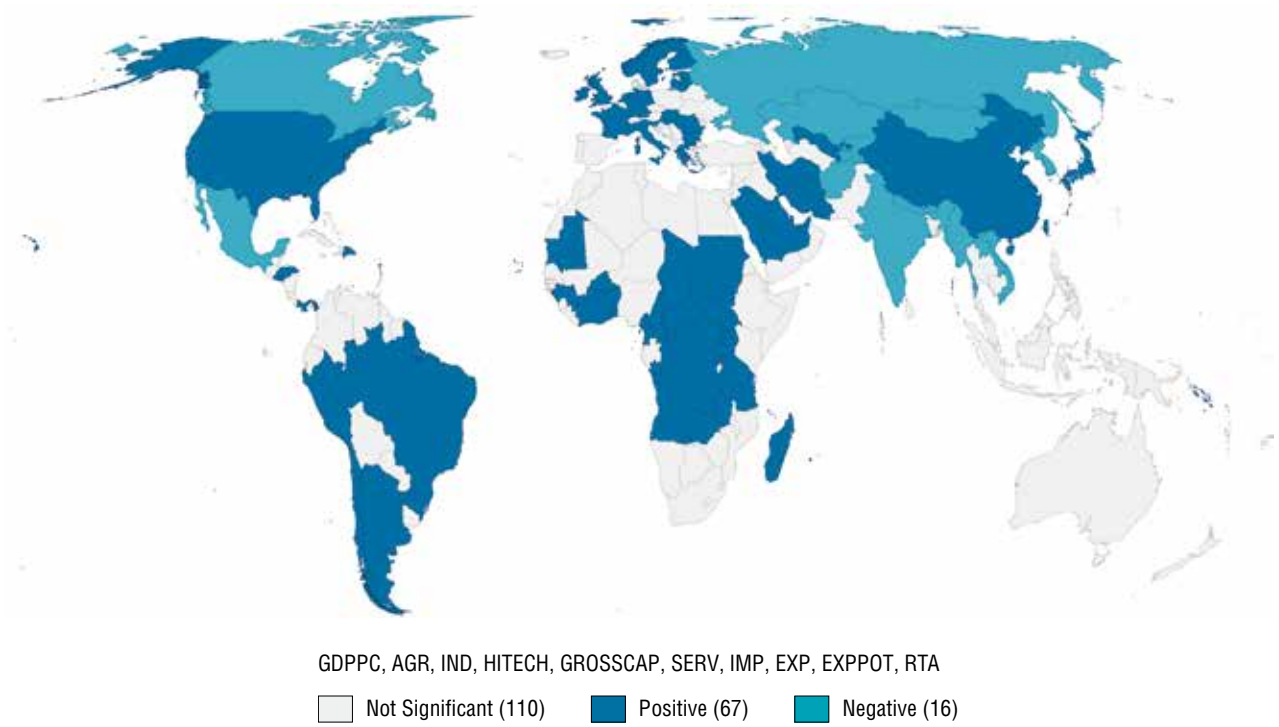


Fig. 3.11.1. "Economy" section spatial autocorrelation cartogram for the geometric neighbourhood matrix

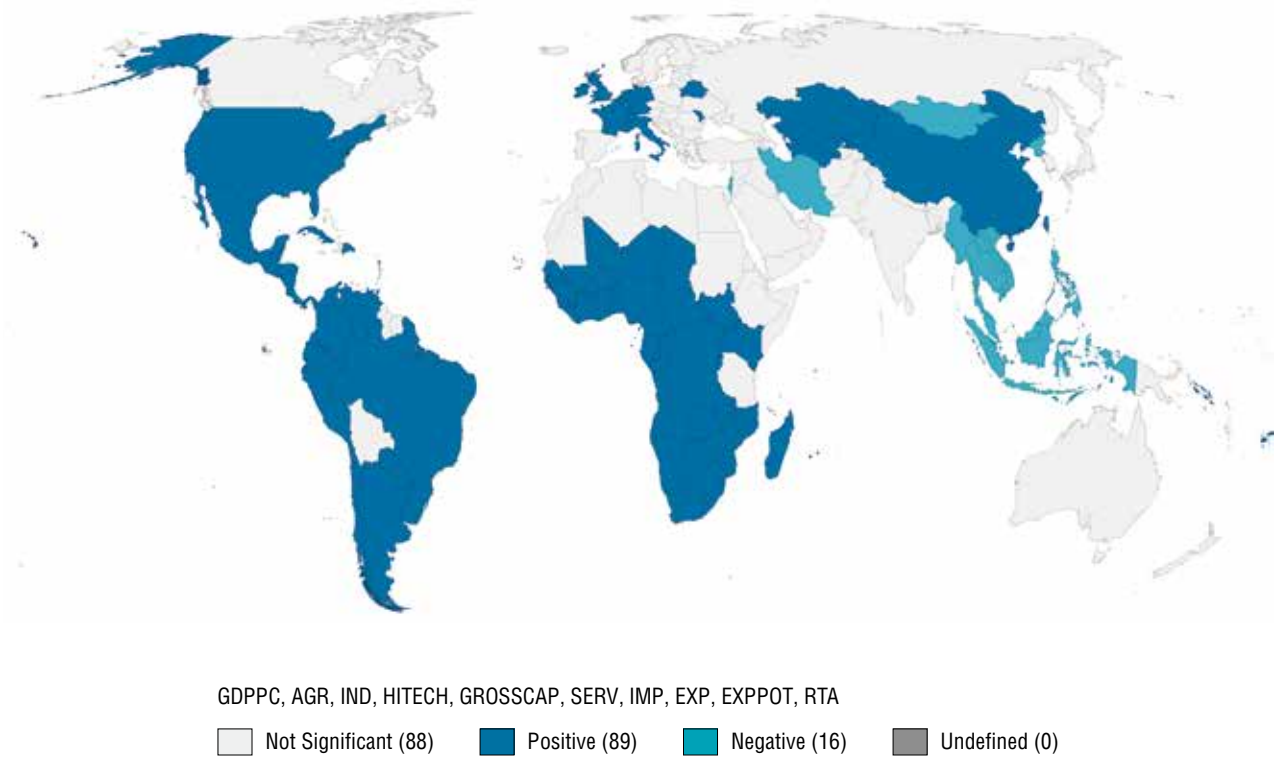


Fig. 3.11.2. "Economy" section spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

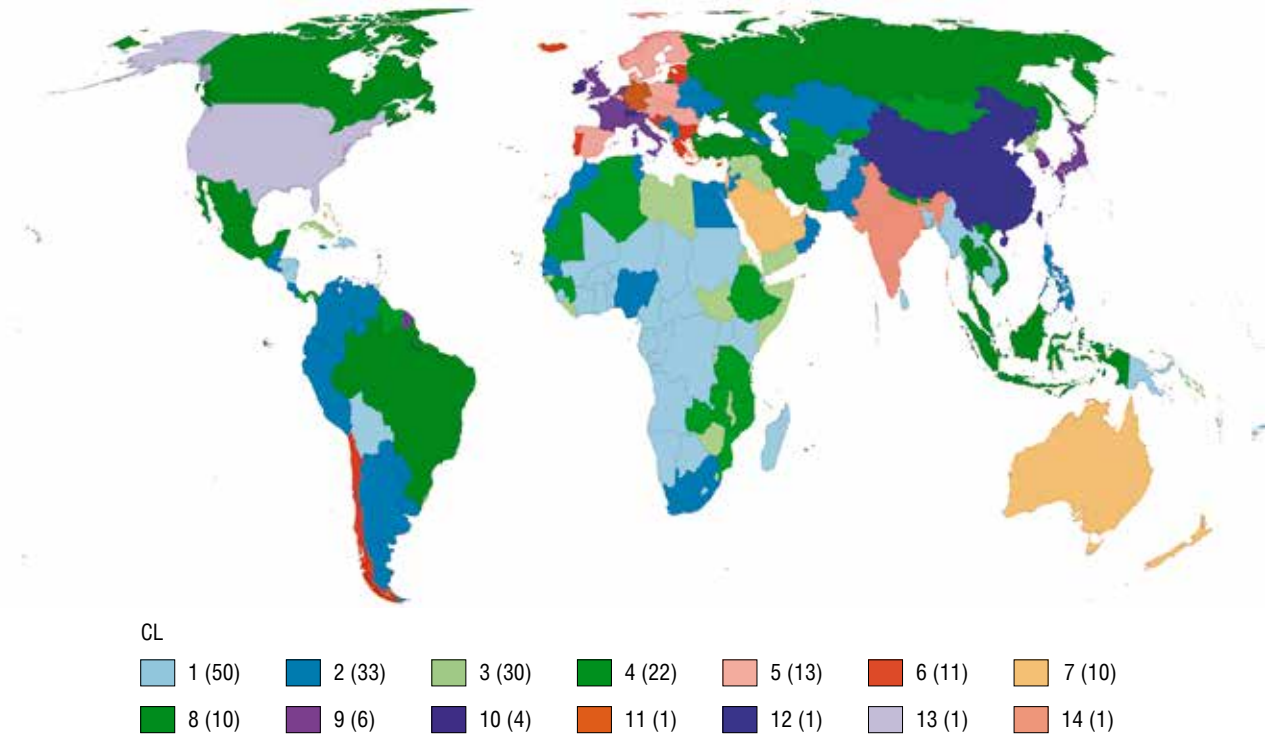


Fig. 3.11.3. Statistical clusters cartogram for the “Economy” section indicators

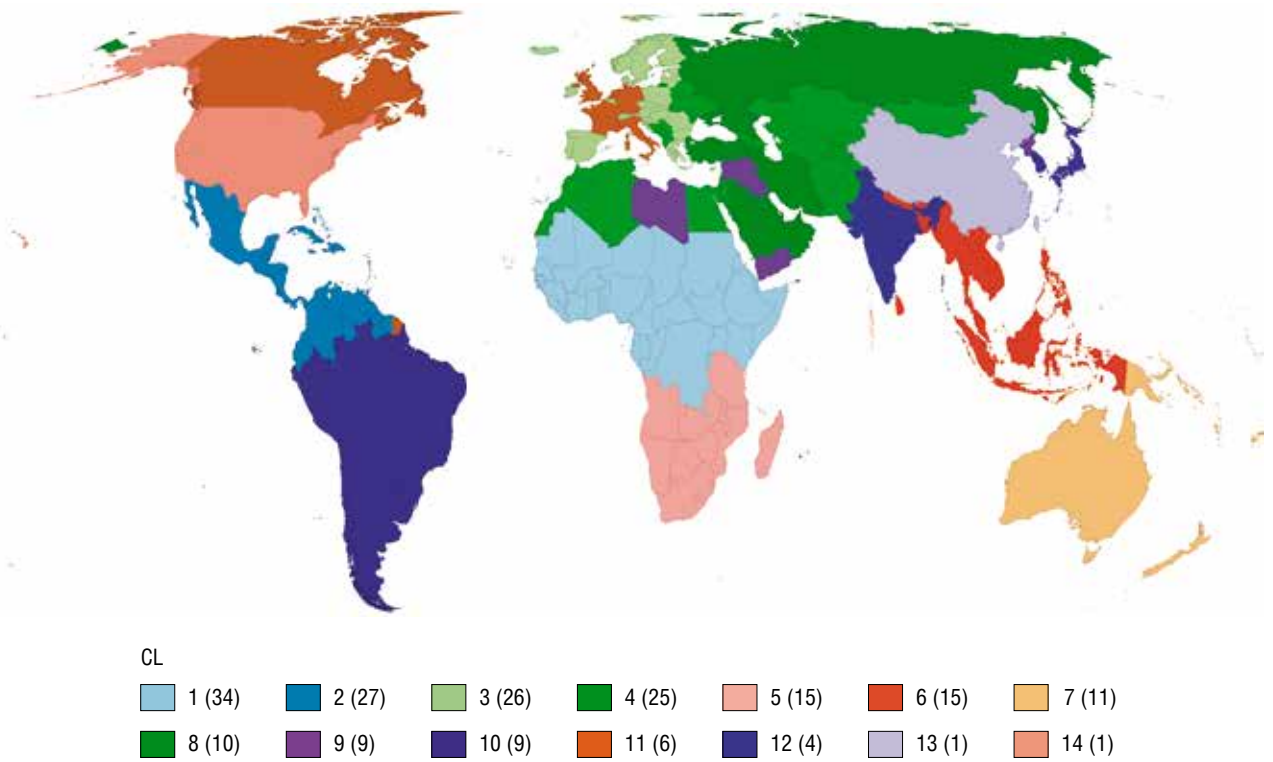


Fig. 3.11.4. Statistical clusters cartogram for the “Economy” section indicators adjusted for geographic proximity

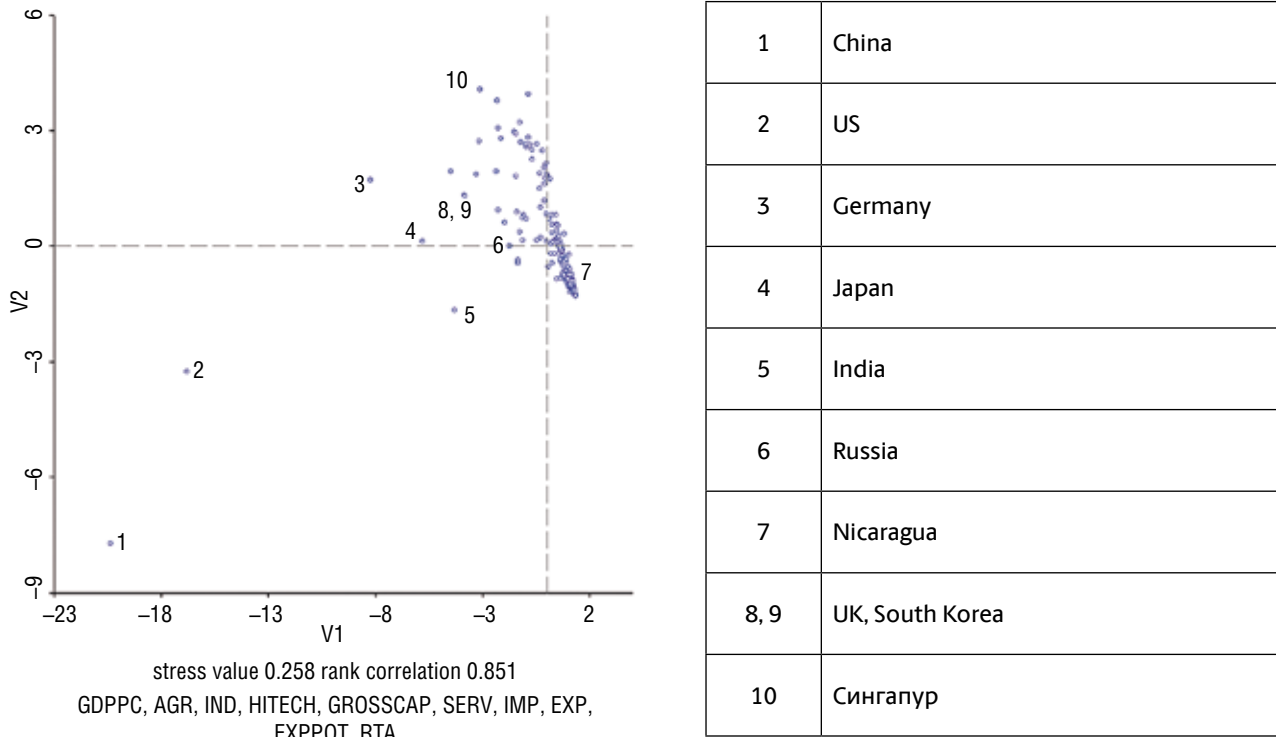


Fig. 3.11.5. Multidimensional scaling chart for the "Economy" section indicators

countries. The cluster of similar countries in Africa increased encompassing several integration systems at once. In Asia there is a cluster including China and Central Asian states.

The geopolitical matrix produced a cluster of countries that are dissimilar to their neighbours in South East Asia.

The cluster analysis cartogram uncontrolled for geographic proximity (Fig. 3.11.3) identifies only individual groups of neighbouring countries that are similar in terms of the median values of their economic indicators.

In Europe Germany stands aside, but next to it there is a nucleus comprising France, Italy and the United Kingdom, surrounded by a belt of Eastern and Northern European countries, as well as Spain. Farther away lies a group of states similar in the median values of their economic indicators. This group comprises the Baltic states, South-Eastern European countries, Portugal and Iceland. The structure of the European integration system is effectively manifested here.

It is interesting that Russia shares a statistical cluster with Turkey, Brazil, Mexico, Canada and Indonesia. A usual cluster of countries lagging behind in economical terms is emerging in Africa.

The second cartogram (Fig. 3.11.4), where the geographic factor is assigned the same value as the sum of all other indicators, shows far clearer clusters. That notwithstanding, some countries continue to stand out. Two global leaders – the USA and China – stand aside. As for the European integration system, its structure still features the most economically developed nucleus in the west of the continent, which now includes Germany. This nucleus is surrounded by a belt of states of Northern, Eastern and South-Eastern European countries, as well as Spain, Portugal, Ireland and Iceland. The Balkans are left out of this belt, they turned out to be closer to former Soviet Republics in Eastern Europe and South Caucasus as well as a number of Arab states. Notably Canada clings not to its neighbours at the American continent, but to the countries of the EU core. A vivid differentiation between Western and Eastern Europe attracts attention as well.

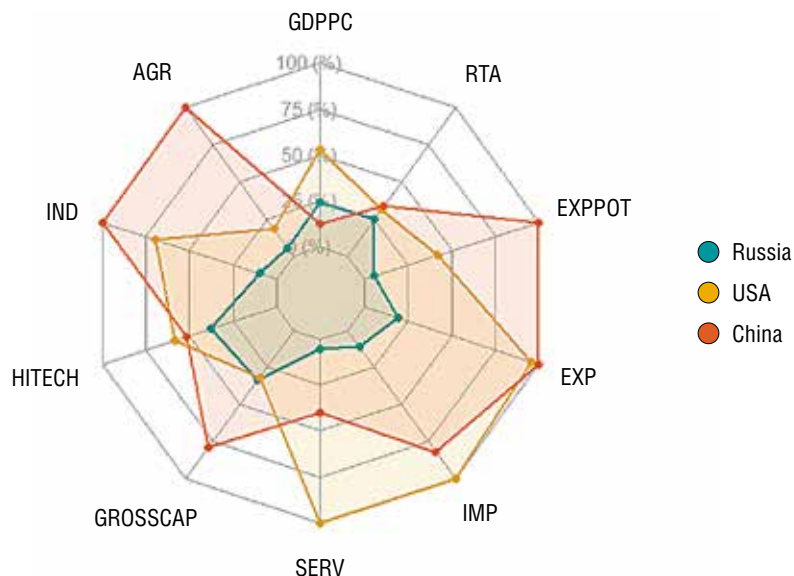


Fig. 3.11.6. Radar chart for the “Economy” section indicators

A vast East Asian cluster has been aligned with Nepal, Butan, Bangladesh and Sri Lanka. Besides Japan, the Republic of Korea and India form one group. Central Asian states that were formerly assigned to different groups are now joined into one with Afghanistan and Pakistan. Russia as a leader of the Eurasian integration system does not share the cluster with its other members.

Notably, the cartogram that combines economic statistics and geographic proximity better reflects international regionalization trends than the automatic breakdown of countries into clusters by geographic proximity.

The world's economic leaders are particular stand-outs on the scatter plot of country values following multidimensional scaling (Fig. 3.11.5). China, and then the United States, are the furthest removed from other states. Germany, Japan and India also stand out, although to a lesser degree. The points for the United Kingdom and for South Korea virtually coincide. Singapore finds itself in the topmost part of the chart thanks to its small size, developed economy and resources. Most countries find themselves in a single elongated cloud. The centre of the constellation includes, for instance, Nicaragua. Even though Russia is close to this cloud, it still stands somewhat apart from it. The closest countries are Brazil, Indonesia, Mexico, Vietnam and Thailand.

3.12. Spatial factor and “Economy” section indicators

A comprehensive analysis of the “Economy” section indicators identified certain spatial effects in their distribution.

Only one indicator selected exhibits sufficiently high Moran's I for both geometric (0.668) and geopolitical neighbourhood matrices (0.596): involvement in regional trade agreements. This means that countries actively involved in regional economic integration are more likely to be surrounded by similar countries, and vice versa. We can assume that this effect is self-enhancing, because regional trade agreements become more attractive for new members the more regional members are involved. Moreover, Moran's I for RTA made top ten of the Atlas's highest indicators. This is the only “Economy” section indicator on the list.

The only other indicators that demonstrate sufficiently high spatial autocorrelation are gross domestic product and the services sector (Moran's I of 0.510 and 0.536 respectively), but only for the geometric neighbourhood matrix. Overall, the hypothesis that the world's geopolitical structure has greater significance is not confirmed for the “Economy” section indicators: Moran's I was always lower for geopolitics than it was for geometry, and the gap was frequently quite large.

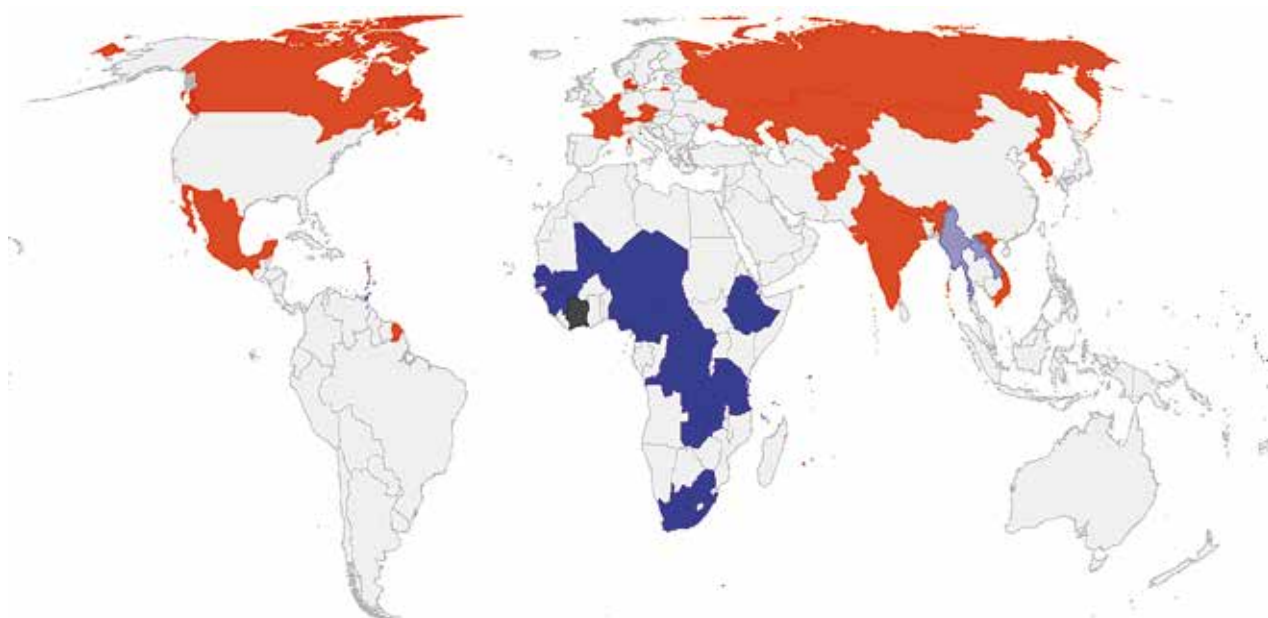
Nevertheless, the distribution of economic indicators does manifest certain spatial patterns. For instance, our findings repeatedly reflected the popular concept of the world being divided into the notional North and South. Such trends were recorded for GDP per capita, Imports, and Exports. Additionally, such economic indicators as Industry, Exports, Imports and Unused export potential demonstrated high spatial effect indices with such geographic indicators as climate and latitude, which also indicates a North-South split. Factors that offset these negative prerequisites for the development of economic and human potential due to being located in a particular region include large hydrocarbon deposits and successful specialization in highly qualified professional services.

The cartograms for two-factor local spatial autocorrelation between the latitudes of capital cities and unused export potential clearly demonstrate a North–South divide (Fig. 3.12.1). Northern countries, primarily those in Western Europe and Eurasia, turn out to be surrounded by countries with high export potential, while the south (Africa) includes an extensive cluster of states whose prospects for building up exports are bleak.

When the geopolitical neighbourhood matrix is used (Fig. 3.12.2), North American countries are lumped together with their European partners into a single high-value cluster. Another such cluster emerges in East Asia, while the African low-value cluster becomes larger. The cartogram also shows two “error” clusters. Even though countries of the Middle East and North Africa tend towards the global North, they do not have high export potential, while countries of Southeast Asia, on the contrary, have major opportunities to expand their exports, even though they tend towards southern latitudes.

Most frequently, two-factor analysis yields a spatial effect index greater than one for GDP per capita and the share of medium- and hi-tech sectors: in both cases, we identified four indicators where two-factor Moran's I squared was greater than the coefficient of determination (R-squared). However, in every case, we are talking a very low coefficient of determination, i.e. a weak correlation.

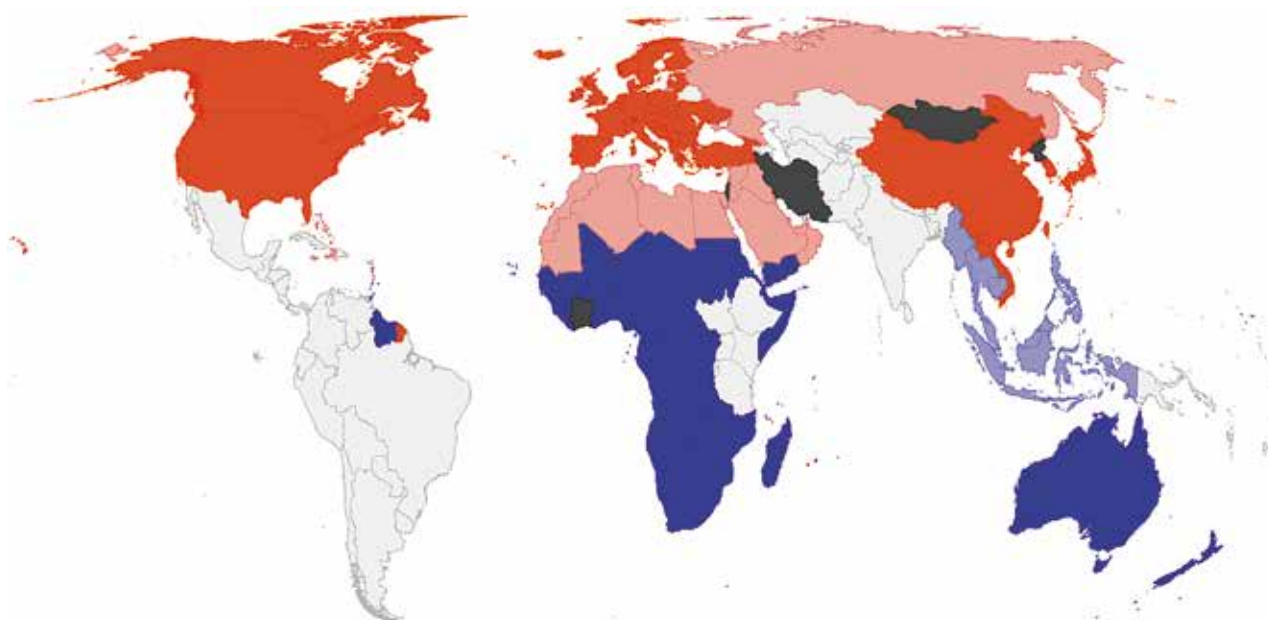
As for regions that were most frequently brought into focus when spatial analysis was applied to economic parameters, there are two groups: 1) African countries that are often grouped into clusters with the lowest indicator values; 2) European states that turned out to be similar in many ways, due, among other things, to the active advancement of European integration, primarily economic integration. In this regard, the results of the inverse cluster analysis of all ten indicators in this section are interesting, as, even if we disregard geographic proximity, they reveal similarities between economies of the nucleus of European countries on the one hand, and their neighbouring states on the other (Fig. 3.12.5). When geographic proximity is assigned the same weight as statistics, the economic structure of the European continent emerges with even greater clarity, and its nucleus and periphery are augmented by another peripheral ring consisting of states of the Southern Mediterranean, Eastern Europe and the South Caucasus (Fig. 3.12.6).



1LAT, EXPPOT

Not Significant (136)
 High-High (22)
 Low-Low (29)
 Low-High (2)
 High-Low (0)
 Undefined (4)

Fig. 3.12.1. Two-factor spatial autocorrelation cartogram for the latitudes of capital cities and unused export potential under the geometric neighbourhood matrix



1LAT, EXPPOT

Not Significant (54)
 High-High (47)
 Low-Low (55)
 Low-High (9)
 High-Low (20)
 Undefined (8)

Fig. 3.12.2. Cartogram of two-factor spatial autocorrelation between the latitudes of capital cities and unused export potential for the geopolitical neighbourhood matrix

Model selection criterion	Indicator	Value	Significance level
Normality of errors	JB p-value > 0.1	—	0.208333
Heteroskedasticity	K (BP) p-value < 0.05	—	0.000036
Multicollinearity	VIF < 7.5	1.984483	—
Spatial Autocorrelation	Moran's I p-value > 0.1	—	0.141029
Lagrange Multiplier – Geometry Weights	Lagrange Multiplier (lag)	4.7826	0.03
	Robust LM (lag)	0.1537	0.70
	Lagrange Multiplier (error)	7.9724	0.00
	Robust LM (error)	3.3435	0.07
Lagrange Multiplier – Geopolitics Weights	Lagrange Multiplier (lag)	2.4753	0.12
	Robust LM (lag)	0.20	0.66
	Lagrange Multiplier (error)	7.5972	0.01
	Robust LM (error)	5.3178	0.02

	OLS	SEM Geometry	SEM Geopolitics
Constant	3.307305 (0.048217)	10.0446 (0.00628)	9.34933 (0.01732)
ROYLT	0.000431 (0.000177)	0.000519418 (0.00055)	0.000444341 (0.00342)
RSRCHRS	0.004112 (0.000000)	0.0026995 (0.00253)	0.0025751 (0.00279)
INTERNET	0.208587 (0.000000)	0.192341 (0.00757)	0.216419 (0.00398)
LAMBDA	—	0.306369 (0.00302)	0.374231 (0.00372)
Heteroskedasticity (Breusch-Pagan test)	23.266124 (0.000036)	5.6326 (0.13092)	8.6089 (0.03497)
Normality of errors (Jarque-Bera test)	3.137237 (0.208333)	—	—
Spatial dependence (Likelihood-ratio test)	—	7.7904 (0.00525)	6.1269 (0.01331)
Akaike information criterion	1500.05	748.976	750.639
Schwarz information criterion		759.274	760.938
R-squared	0.597882	0.594027	0.583881

* P (P-value) significance level is given in brackets.

The geographically weighted regression method identified the following model as being the most valid for the section's indicators. A direct regressive dependence of the share of medium- and hi-tech sectors in industrial production (HITECH) was established on the following combination of independent variables: royalty payments for the use of intellectual property (ROYLT); the number of researchers engaged in R&D (R&D) per 1 million population (RSRCHRS); and the share of internet users in the population (INTERNET).

Although the regression coefficient is average (a little under 0.6), we can propose a hypothesis that the "percentage of researchers" indicator serves as a prerequisite for the growth of hi-tech production thanks to

scientific achievements, and it may also attest to the attention that both the government and the private sector pay to research. High royalty payments to foreign copyright holders may be a sign of a well-developed intellectual property protection system, which may also serve as an incentive for researchers to apply for patents and work on new inventions. The high percentage of internet users means that a developed infrastructure for internet services is required, and shows that digitization efforts are well under way. This, in turn, stimulates the optimization and improvement of manufacturing processes through the widespread introduction of hi-tech solutions.

The Lagrange multiplier allowed the research team to establish that the spatial error method is preferable for both the geometric and geopolitical neighbourhood matrices. That is, the neighbourhood effect in both geometric and geopolitical matrices reduces the model's efficiency only slightly. The Akaike information criterion indicates that the spatial error method has far greater validity than the non-spatial model. The Schwarz information criterion indicates that a comparison of spatial models for geometry and geopolitics proves the geometric model to be more valid. Its R-squared is also somewhat higher (0.594) than that of the geopolitical model (0.584).

The standard deviation cartogram shows that this model is valid for Russia, Mongolia, the Baltic countries, Poland, France, Spain, United Kingdom, a large number of sub-Saharan African countries, and countries in the southwest of South America. It is least applicable to Iceland and India.

Overall, spatial factors, including the neighbourhood effect, have quite a significant influence on the distribution of the world's economic potential, which reinforces and somewhat enhances regional disproportions. Consequently, these specifics need to be accounted for when formulating development strategies for human potential.

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4

Finances

Tax revenues

Budget deficit

Sovereign debt

Bank deposits

Short-term consumer loans

Loans to domestic companies

Foreign assets

Inward FDI debt stocks

FDI inflows

Royalties to foreign copyright holders

*Multifactor analysis of the “Finance”
section indicators*

*Spatial factor and “Finance”
section indicators*

DEVELOPING human potential without financial investments is fairly difficult. Having earmarked large funds for the Millennium Development Goals, many states continued to address the tasks that have been set. The World Bank's involvement in supporting the population in many areas attests to the decades-long shortages of funding in many spheres: from procuring medications and medical equipment [Tichenor, Sridhar 2017] to food manufacturing [World Bank 2007].

When the coronacrisis broke out, many states and international organizations took these very close ties between human capital and financial capital into account and developed a set of instruments intended to provide financial aid for the most vulnerable countries and population groups. A few weeks after the COVID-19 pandemic was declared, UNCTAD called for extending targeted support to victims. To this end, it provided USD 1 trillion of additional liquidity, limited short-term capital outflows and introduced measures to relieve the debt burden [UNCTAD 2020, 11].

However, these financial injections may prove insufficient for those countries that do not have significant resources of their own. From this point of view, developing countries are often advised to develop many human capital aspects, relying on mobilizing internal resources instead of outside investors and aid donors [UNICEF 2014, 4]: for example, by earmarking profits from resource sales to employment, social services, public procurement and infrastructure [African Development Bank Group 2015, 9].

As regards financial stability, the following parameters of a crisis state budget have the greatest importance for human potential: budget deficit [Roxburgh et al. 2010, 75] and means of filling up the treasury using taxes and levies [Rathin 2009]. Citizens of states with prohibitive debt may suffer from global socioeconomic instability [Roxburgh et al. 2010, 84; Kosolapova 2020, 5], although loans frequently advanced the development of human potential in less volatile economic circumstances [Ogbeide & Kanwanye 2016]. It is worth pointing out here that the close interconnections between financial markets that we have seen in recent decades have increased the sensitivity of populations in many regions to global crises, accelerating the emergency outflow of capital from employer companies in developing states into developed states [UNCTAD 2020, 4, 7–8].

This section demonstrates the distribution of principal indicators of the financial circumstances of states, companies and natural persons that meet most of the requirements listed in the methodological section. We have attempted to demonstrate the means at the disposal of economic agents, whether they attract additional resources from partners (in the form of loans or foreign investment), and the cost of using these funds. Unequal capital provision is manifested in the fact that many companies allow their foreign partners to use their excess funds.

Given the importance of the anti-crisis policies pursued by governments during the COVID-19 pandemic, the first indicators subject to analysis are those that measure financial stability. It is important to remember that many characteristics of public spending, national economies, and social welfare are described in other sections of this Atlas.

4.1. Tax revenues

The tax revenues indicator measures the percentage GDP that is re-distributed by the government. The mean and median values for all countries do not evidence a significantly skewed distribution: the difference between these central tendency measures is small. The values obtained make it hard to claim that most governments (as, for instance, the government of Denmark and other countries with a Scandinavian socioeconomic model) tend to become economically involved in this way or, on the contrary, avoid tax burden.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.169	0.000	0.197	0.000
Geary's C	0.801	0.000	0.799	0.000

The percentile cartogram (Fig. 4.1.1) shows that states with European socioeconomic models stand out, as high taxation rates are frequently declared as a means of raising public social spending. In turn, spending in these countries is traditionally (more frequently than in the American model) financed publicly rather than privately. The same approach to taxation is demonstrated by some former colonies of European powers (for instance, South Africa, Chile, Australia). Tax revenues in other countries (especially in Asia and in Tropical Africa) are not large.

Spatial autocorrelation calculations for both geometric and geopolitical neighbourhood matrices yield similar conclusions. These findings do not allow us to claim that the global geopolitical structure (states' membership in the same international organizations) is more important than geography (having a common border).

The first spatial autocorrelation cartogram (Fig. 4.1.3) shows France and Belgium (countries with high tax revenues) surrounded by countries with similarly high indicators. Many of their relatively high-income citizens can afford to pay higher taxes (in particular, because TNCs have headquarters in these countries), and they tend to elect leaders who keep a relatively high taxation rate.

Vanuatu and the Caribbean islands attract corporate taxpayers with their simplified registration procedures and soft taxation regimes. Tax revenues in these countries (from both offshore companies and

Global place	Country	Indicator (% of the GDP)
1	Seychelles	34.1
2	Denmark	32.4
3	Lesotho	31.6
Mean, Median (68–69)	Poland, Malawi	17.4
134	Myanmar	5.4
135	Iraq	2.0
136	United Arab Emirates	0.1

tourism) thus appear large compared to their mostly agriculture-based GDP. Botswana stands out in Africa: its high level of tax revenues stems from the production of extractable resources (mostly diamonds), rather than from the relatively modest income of natural persons.

Further north, in Gabon, the Congo, Cameroon, the Central African Republic and Sudan, we observe a cluster of low tax revenues. Presumably, the uncollected taxes from agricultural producers, the few large manufacturing companies, and the relatively poor population is not offset by the influx of funds into the treasury from the production of extractable resources (for instance, in Gabon).

As a rather poor agrarian country, Sri Lanka's tax revenues are at roughly the same low level as its neighbours, in particular, India where many taxpayers live in rural areas and cannot ensure tax revenues at the level of large modernized manufacturers.

When spatial autocorrelation indicators are calculated under the geopolitical neighbourhood matrix (Fig. 4.1.4), states are analysed in a broader context: they are compared not only to their immediate neighbours, but also to their geographically distant partners in international relations. The cartogram shows that tax revenues in Australia, Vanuatu and the Solomon Islands are equally high, while those in the Middle Eastern and North African economies are all low. At the same time, countries that are members of European and North American integration alliances and other international organizations manifest a greater diversity in these parameters. In some states (particularly those that pursue a "night watchman" fiscal and economic policy, such as the United State), tax revenues appear low compared to maximum (compared to the overall global policies) share of revenues received by Danish, French, Belgian, and other tax services.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Tax revenues" parameter (Fig. 4.1.2) identified states with similar indicator values that are not anomalously high or low (as on the spatial autocorrelation cartogram). Dense connections between a group of West African states and other connections between East Asian states show that combinations of taxpayer solvency and fiscal policy in these two categories produce homogeneous results.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	GDP (PPP) per capita	0.033	0.035	0.199	1.205
2	Healthcare spending	0.051	0.008	0.24	1.127
3	Tertiary education enrolment	0.059	0.008	0.231	0.906
4	Agriculture	0.034	0.034	-0.169	0.844
5	Years at school	0.096	0.000	0.284	0.837
6	Particulate air pollution	0.196	0.000	-0.394	0.791
7	Population growth	0.075	0.001	-0.244	0.790
8	Life expectancy	0.080	0.001	0.246	0.760
9	Young population	0.077	0.001	-0.241	0.754
10	Passport power	0.160	0.000	0.341	0.728

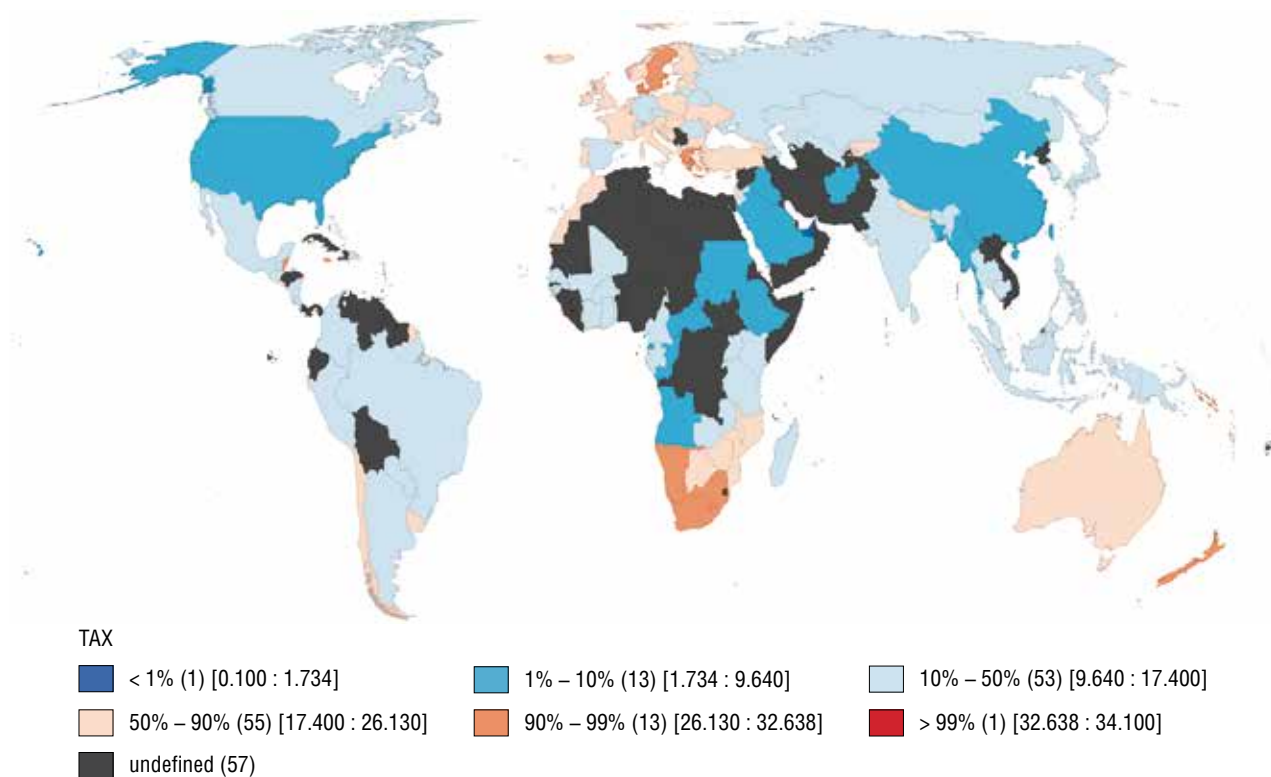


Fig. 4.1.1. Percentile cartogram for the “Tax revenues” indicator

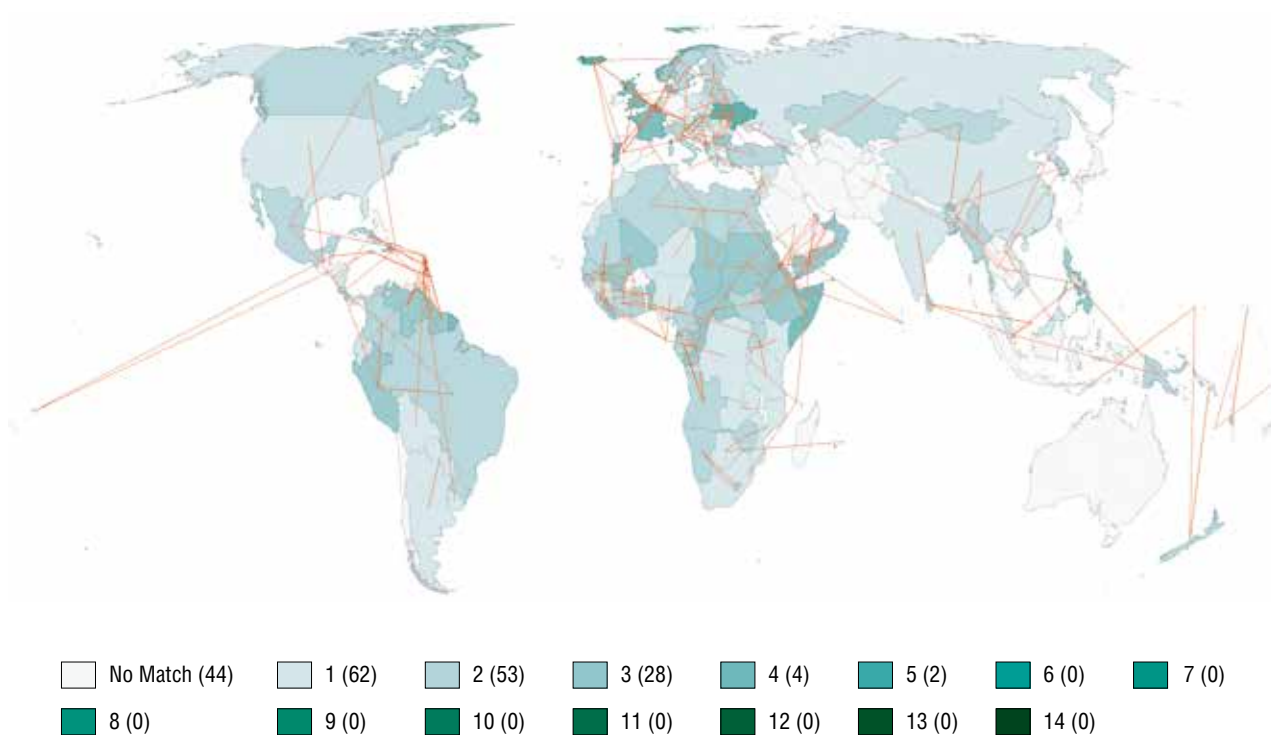


Fig. 4.1.2. Likelihood-ratio test for the “Tax revenues” parameter

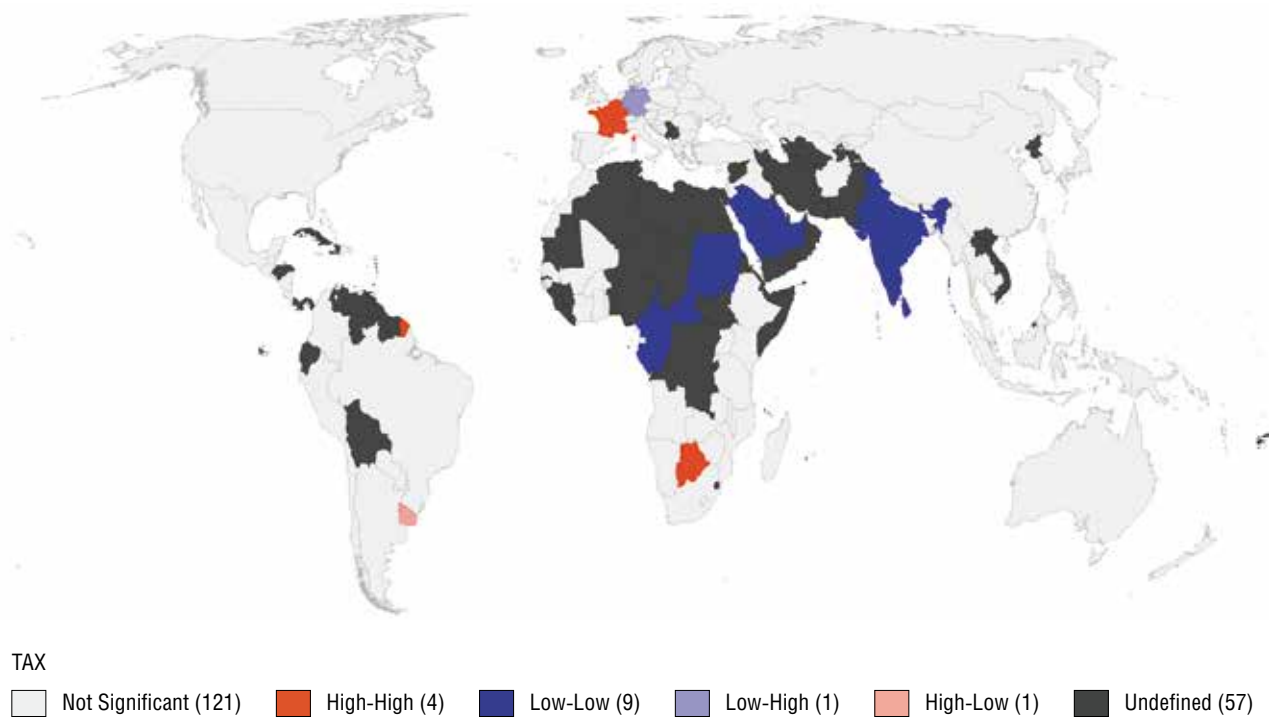


Fig. 4.1.3. “Tax revenues” spatial autocorrelation cartogram for the geometric neighbourhood matrix

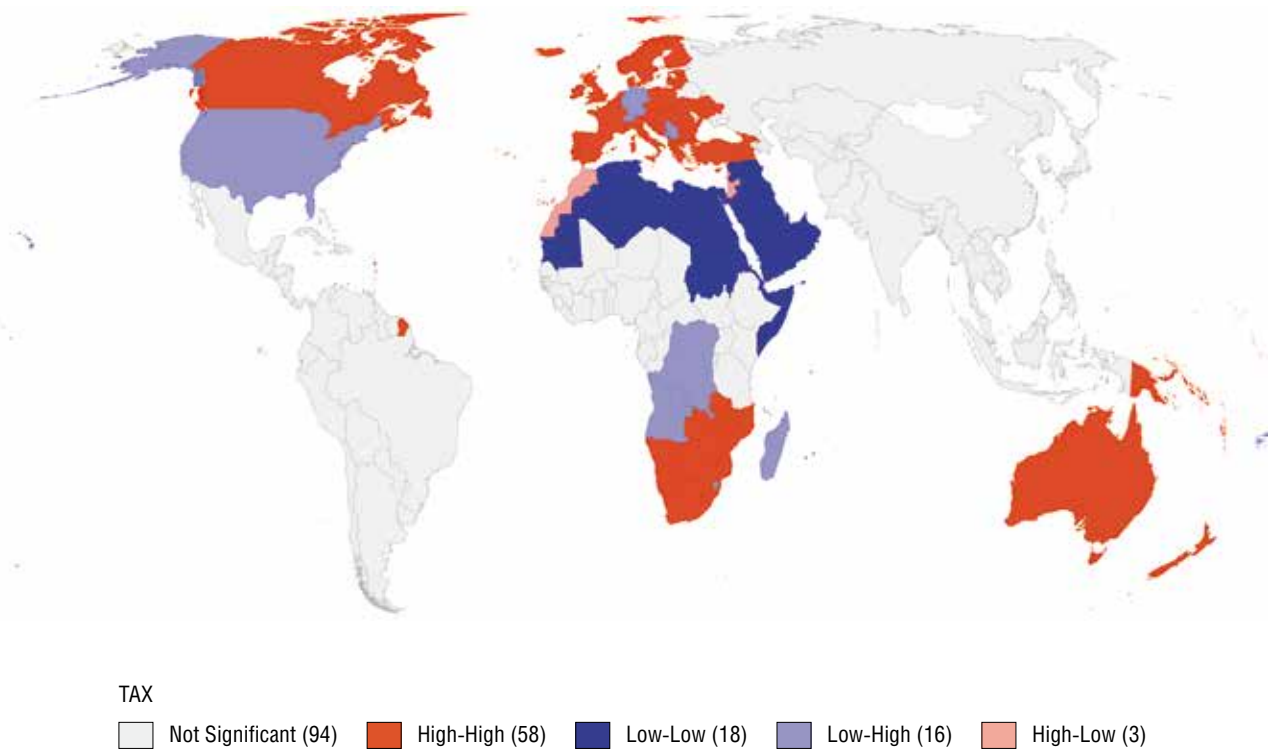


Fig. 4.1.4. “Tax revenues” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.2. Budget deficit

The budget deficit to GDP ratios in different countries in 2019 reveal which governments fail to balance their revenues with their planned spending. The mean and median values for all countries do not evidence a significantly skewed distribution: the difference between these central tendency measures is small. At the same time, the range of values shows significant deviations from a balanced budget both towards a budgetary surplus (frequently in resource-rich countries: Azerbaijan, Norway, the Congo, etc.) and a budget deficit (for instance, in Venezuela due to hyperinflation affecting prices of goods and services paid for by the government; East Timor, due to the need to repair the power grid and road network, which were under-financed before independence).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.052	0.100	0.077	0.002
Geary's C	0.914	0.181	0.918	0.002

Despite the volatility of budget deficit from year to year (in particular, due to unstable revenues), the scale cartogram (Fig. 4.2.1) yields the following findings. Before the coronacrisis, most countries with a surplus or moderate budget deficit were situated in resource-rich territories, the north of Eurasia (which have smoothly working budgetary discipline mechanisms), and among ASEAN member states (those that are saving up for a possible military conflict).

Autocorrelation coefficients for the geometric neighbourhood matrix were insignificant because of the increased volatility of the indicator. In the year the data was collected, neighbouring governments that typically have a budget surplus may have implemented costly short-term reforms, while a neighbouring country that traditionally has budget deficit could temporarily implement austerity measures.

At the same time, the geopolitical neighbourhood matrix yields a significant autocorrelation. Apparently, this is explained by measures some integration alliances adopt to align their budgetary policies (for instance, the European Union introduced the “Maastricht criteria” and the European Semester).

In Germany and Sweden, public revenues are almost at the same level as public spending, and the same is true for most of their neighbouring states in the geometric matrix (especially compared to the large surplus in Norway's budget — Fig. 4.2.3). Although these countries traditionally have 100% budget perfor-

Global place	Country	Indicator (% of the GDP)
1	Azerbaijan	8.1 (surplus)
2	Norway	7.8
3	Congo	5.8
Median (56–57)	Hungary, Ukraine	–2 (deficit)
Mean (60–62)	(UK, Dominican Republic, Indonesia)	–2.2330 (–2.2)
110	Venezuela	–10.0
111	Sudan	–10.9
112	East Timor	–32.1

mance (in particular, striving to provide their citizens with social services), their high economic development level and disciplined policy prevent their budgets from becoming unbalanced.

On the contrary, the budgets of Ethiopia and its neighbours have extremely large deficits. The countries of the region are characterized by poverty (an obstacle in the way of increasing public revenues), large-scale corruption, and poorly qualified public servants in charge of the frugal distribution of funds. The budget deficit in Saudi Arabia, which is also surrounded almost exclusively by states with budget deficits, may be explained by other reasons: significant revenues from the extraction of natural resources were spent on the accelerated modernization of infrastructure and the economy in general.

Spatial autocorrelation calculated for the geopolitical neighbourhood matrix (Fig. 4.2.4) revealed low-low clusters in Latin America and in ASEAN+3. In both cases there are exceptions: in Latin America those are Bolivia and Paraguay, some of the poorest countries of the continent with a high budget deficit. In the South-Asian cluster Thailand and the Republic of Korea stand out with a much higher deficit than that of their neighbors. South Korea's state finances are undermined by negative demographic trends, which push the Korean government to increase public spending as well as foreign debt. In the recent years the authorities have tried to reduce the budget deficit, however, they have to decrease crucial expenditure items, such as research and development or regional education budgets, which can further undermine long-term social and economic prospects of the country.

Indian budget deficit is also higher than that of its neighbours. The reason is a large-scale governmental programme aimed at developing infrastructure, creating new jobs and improving the education system for high-skilled workers. The increase of the budget spending is partially justified by the high GDP growth rate.

Comparing proximity of states in the geographic space and in the budget deficit values space (Fig. 4.2.2) draws attention to a group of East African states. A group of Northern European states whose governments adhere to the budgetary discipline (and sometimes austerity) principle appears equally homogeneous.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Availability of electricity	0.064	0.008	0.117	1.265
2	Suicide rate	0.050	0.026	0.250	1.254
3	Elderly population	0.06	0.009	0.255	1.079
4	Passport power	0.067	0.006	0.254	0.968
5	Tertiary education enrolment	0.063	0.010	0.244	0.948
6	Secondary education enrolment	0.040	0.042	0.185	0.855
7	Healthcare spending	0.077	0.003	0.253	0.836
8	Corruption	0.065	0.007	0.231	0.823
9	Number of doctors	0.089	0.001	0.270	0.821
10	Loans to domestic companies	0.045	0.026	0.186	0.760

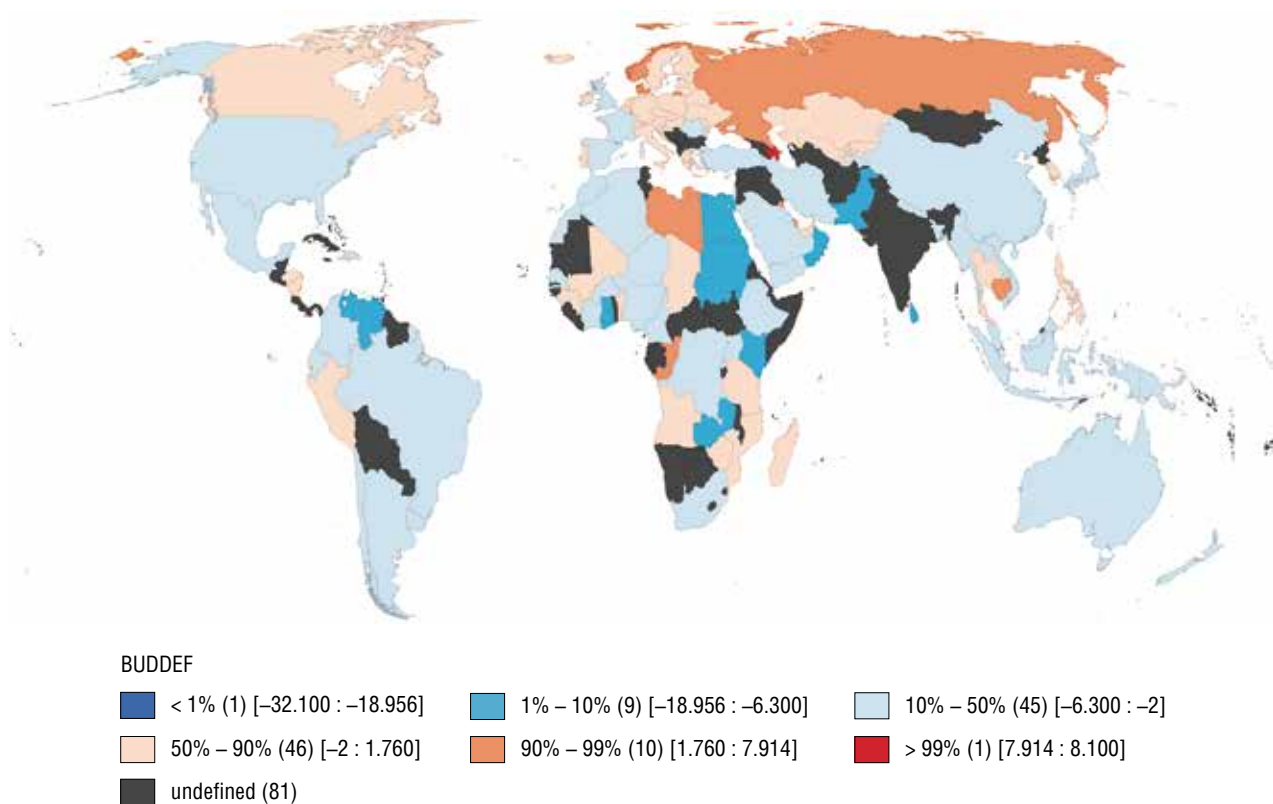


Fig. 4.2.1. Percentile cartogram for the “Budget deficit” indicator

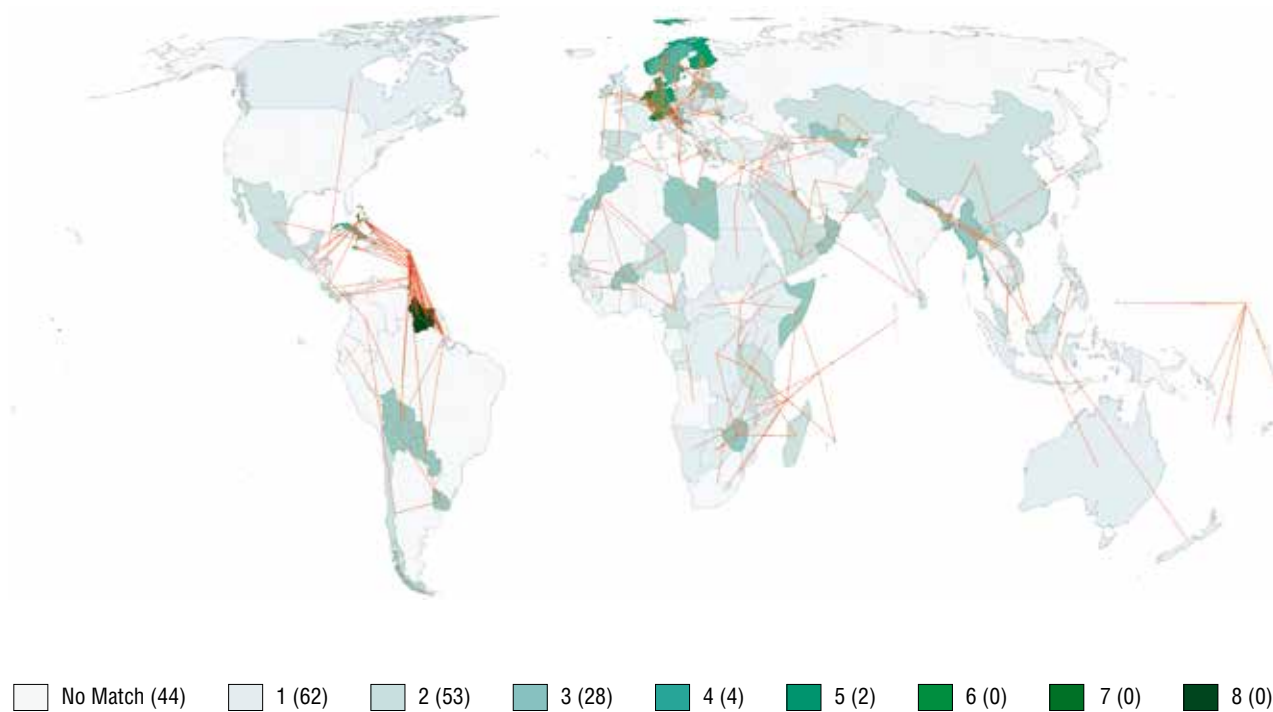


Fig. 4.2.2. Likelihood-ratio test for the “Budget deficit” indicator

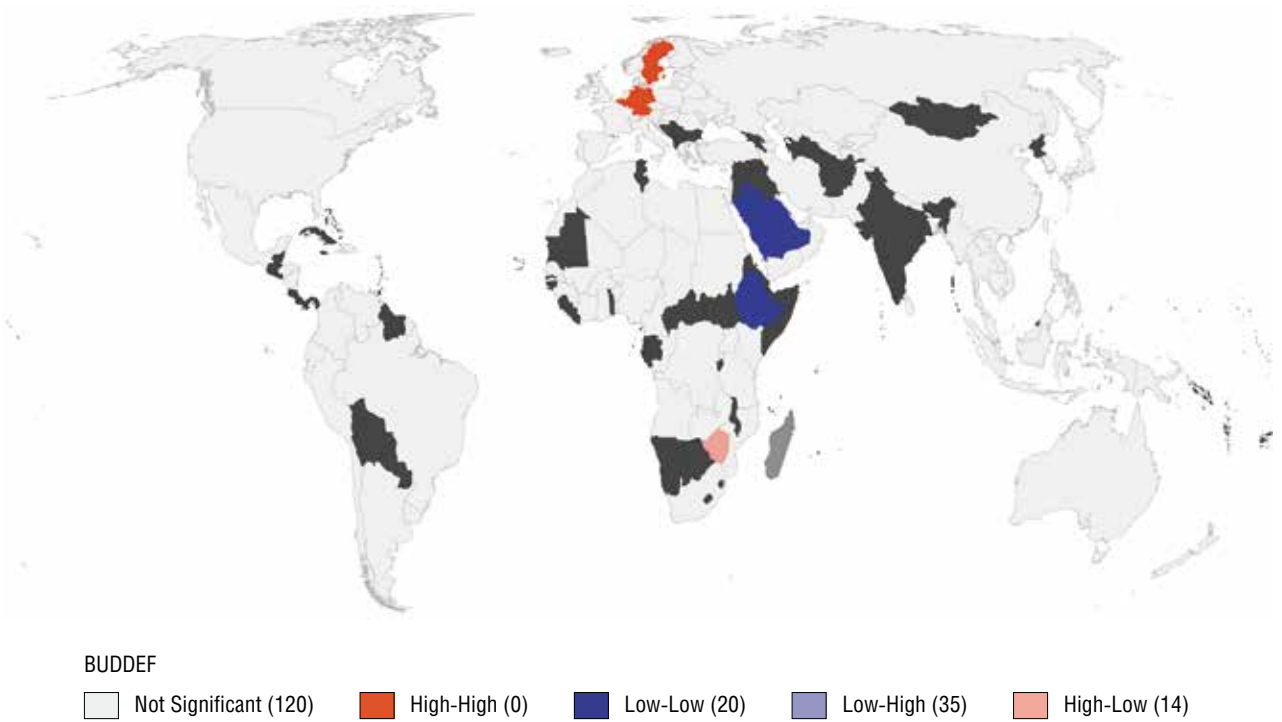


Fig. 4.2.3. “Budget deficit” spatial autocorrelation cartogram for the geometric neighbourhood matrix

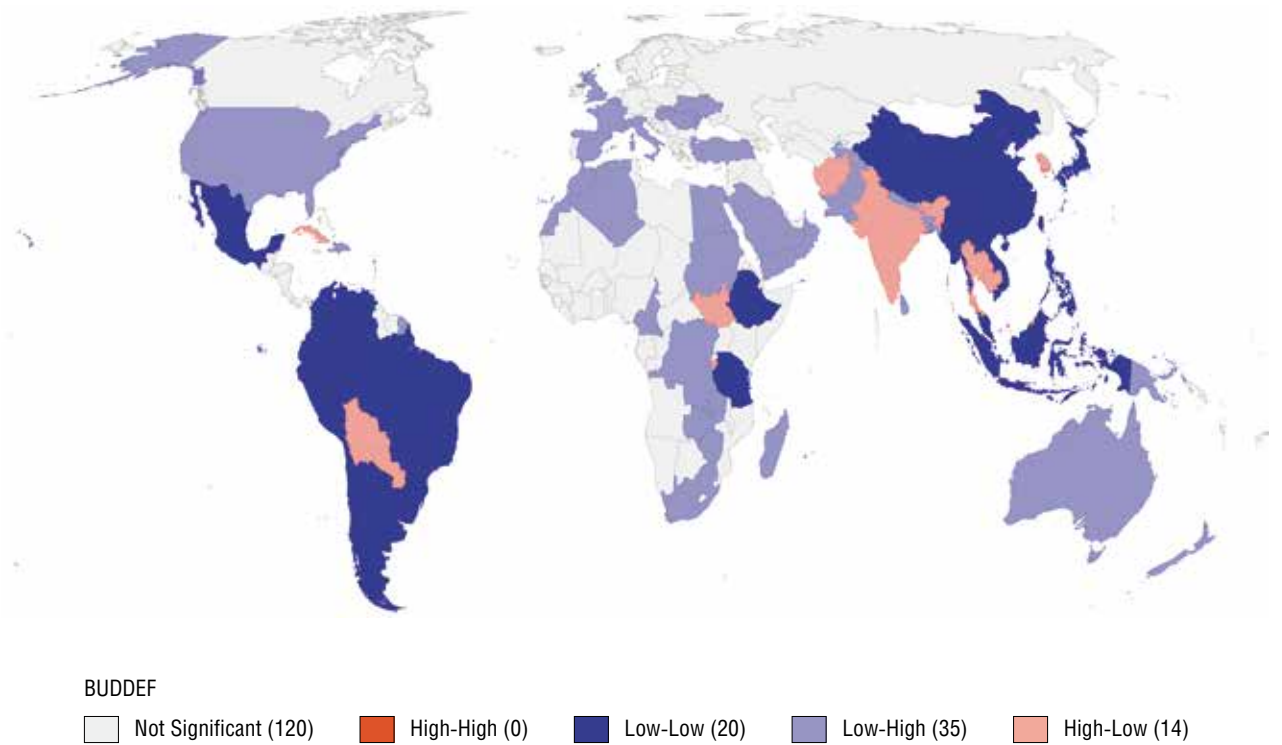


Fig. 4.2.4. “Budget deficit” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.3. Sovereign debt

Sovereign debt to GDP ratio primarily shows the degree to which governments used loans to cover their previous budget deficits. States whose financial stability is bolstered by their ability to borrow money in their hard currency demonstrate extremely high values for this indicator: the United States, the Eurozone countries, and Japan (4.3.1). Some island states in the Caribbean racked up their foreign debt as they strove to offset the shortage of extractable resources and counted on the stability of their offshore development model.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.024	0.267	0.044	0.049
Geary's C	0.923	0.113	0.951	0.049

Less financially stable countries, primarily developing Asian states, actively took out loans. Large remunerations prompted creditors to meet the demand for money even from such failed states as Eritrea and Venezuela.

The mean and median values for all countries do not evidence a significantly skewed distribution: the difference between these central tendency measures is small. These values make it difficult to judge whether most governments tend to borrow money or fear loans.

Unlike the countries with the highest values, Afghanistan received almost no development loans (just like the countries of Tropical Africa, where, instead of loans, foreign states frequently sent official development assistance [ODA]). Brunei recorded the lowest debt levels, which is due to its wealth of resources and balanced spending on infrastructure. In order to join the Eurozone, Estonia's governments adopted political decisions to exceed the "Maastricht criteria" (which include limiting the debt burden).

The spatial autocorrelation cartogram reveals no clusters by the sovereign debt, which proves once again how unaffected by the neighborhood effect this parameter is. It is only possible to analyse that Mexico with a relatively high rate of sovereign debt neighbors Cuba with the relatively low rate. In Europe Spain stands out with its debt matching the level of neighboring countries, for instance, France. These and some

Global place	Country	Indicator (% of the GDP)
1	Japan	237.96
2	Venezuela	232.79
3	Eritrea	189.22
Mean (73)	(Saint Kitts and Nevis)	57.8849 (57.94)
Median (89)	Armenia	50.07
175	Estonia	8.41
176	Afghanistan	6.81
177	Brunei	2.57

other Southern European countries suffered most during the economic crisis of 2010s, which prevented them from paying off their debts quickly.

Israel's large debt, which is similar to that of most neighboring states, may stem from political tensions in the Middle East, which forces the country to borrow for military spending. Neighboring Egypt's high sovereign debt differs from that of its neighbors. Politically and economically challenged Iraq probably could not acquire large debt, which is characteristic of some of its neighbors as well. The same is true for the Central African Republic. Whereas Ethiopia with a higher rate of debt differs from neighboring African states.

Several Asian countries with low sovereign debt matching that of their neighbors are Mongolia, the Philippines and East Timor. However, none of them formed any clusters, presumably due to the high statistical mistake for other countries. Japan falls into the group of "mistakes", because its sovereign debt is much higher than that of its neighbors.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 4.3.4) reveals a low-low cluster in the post-Soviet space including Russia, Azerbaijan and Turkmenistan, the resource-producing countries of the region that can substitute credits with revenues from exporting energy resources. Next to this cluster is Kyrgyzstan with a relatively high debt. The leaders of Nepal, whose low debt compared to its neighbours is specifically noted on the cartogram, could fear dependency on private (and particularly foreign) lenders. Unlike its neighbours, Afghanistan was not in dire need of loans, since the necessary funds came from the official development assistance.

Australia and its international organization partners in Oceania also formed a single cluster. The Australia government receives revenues from coal production, while Papua New Guinea, Fiji and Vanuatu do not strive to expand their social spending to such a degree that it would require additional financing.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Sovereign debt" parameter (Fig. 4.3.2) reveals close values not only among the EU members mentioned above and the islands of Oceania, but also between Latin American and Southern African countries. Latin American governments have owed money since the 1990s, when the Washington Consensus Reforms had resulted in a debt crisis. Sub-Saharan African countries have not cleared their debts since the beginning of a wave of political instability and the "demographic transition" that demanded investment in the social sphere.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Number of doctors	0.023	0.044	0.094	0.381
2	Marriage	0.045	0.005	-0.111	0.276
3	Young population	0.027	0.032	-0.086	0.275
4	Urbanization	0.046	0.004	0.110	0.261
5	R&D spending	0.034	0.04	0.087	0.225
6	Diplomatic missions	0.150	0.003	0.172	0.197
7	Quality of education	0.027	0.032	0.070	0.173
8	Cultural exports	0.059	0.005	0.081	0.112
9	Hospital beds	0.042	0.043	0.067	0.106
10	Bank deposits	0.099	0.00006	0.102	0.105

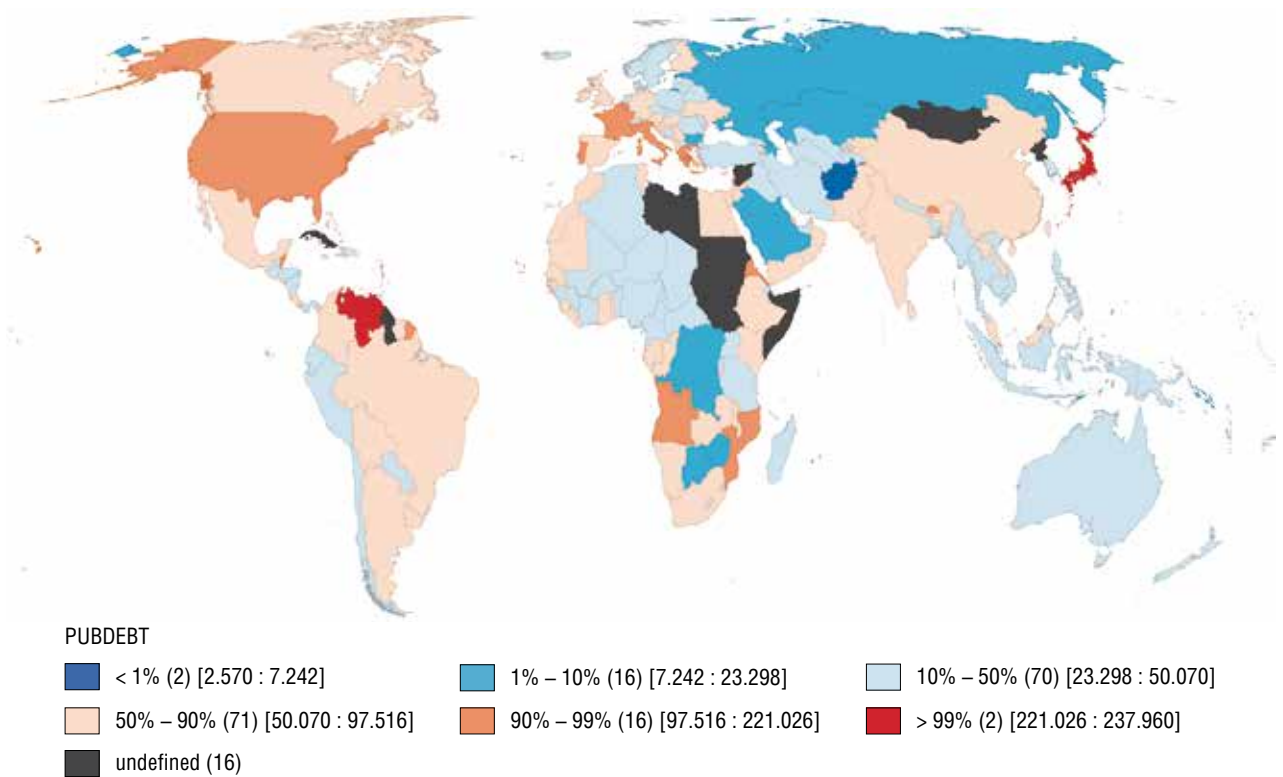


Fig. 4.3.1. Percentile cartogram for the “Sovereign debt” indicator

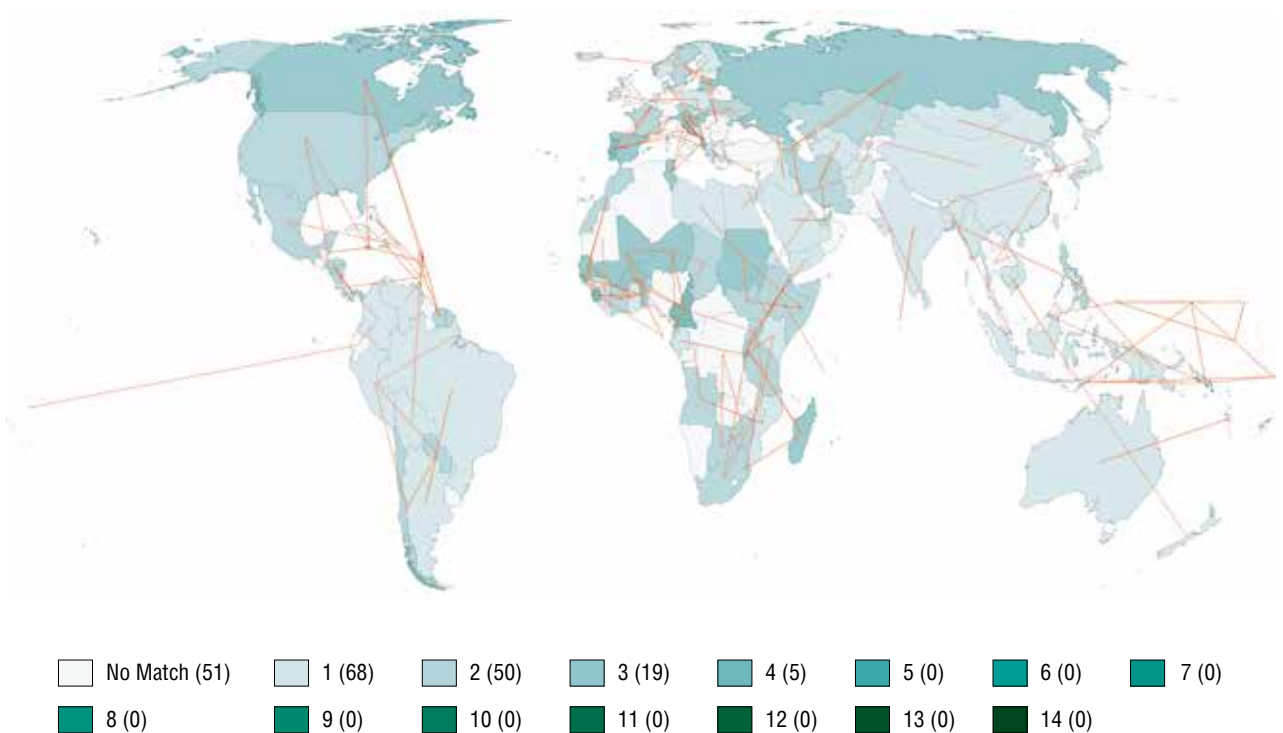


Fig. 4.3.2. Likelihood-ratio test for the “Sovereign debt” parameter

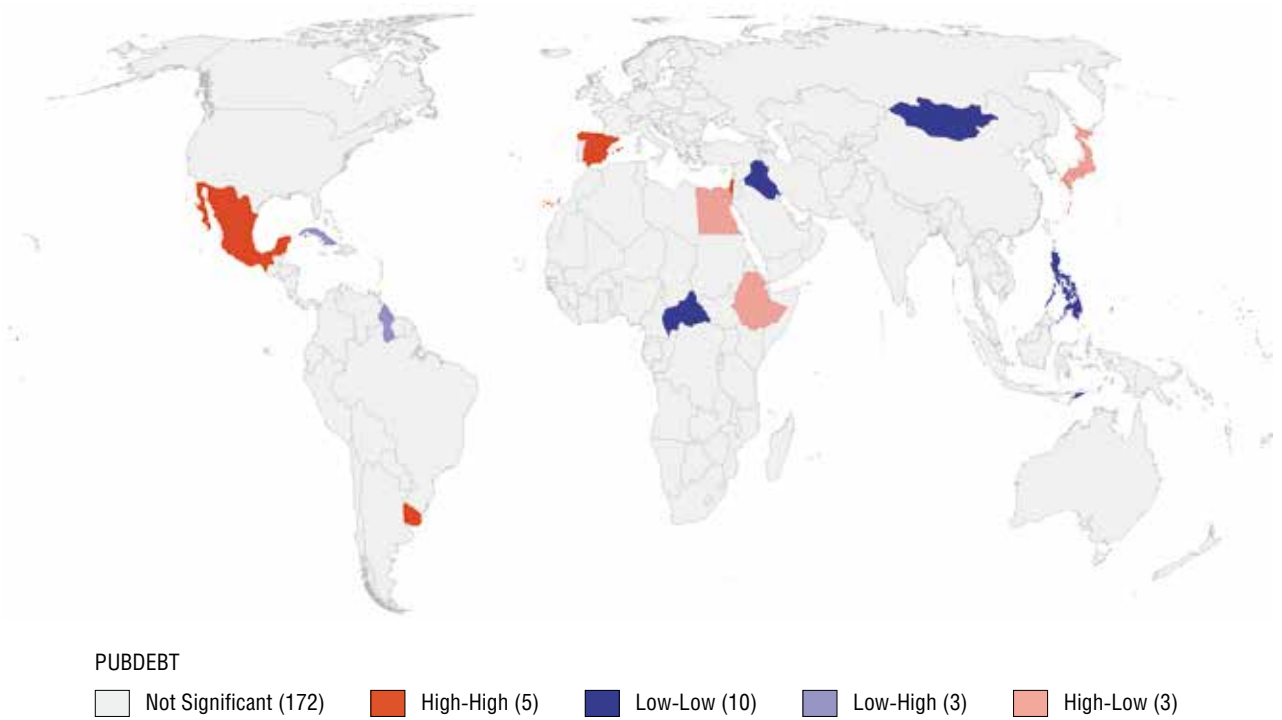


Fig. 4.3.3. “Sovereign debt” spatial autocorrelation cartogram for the geometric neighbourhood matrix

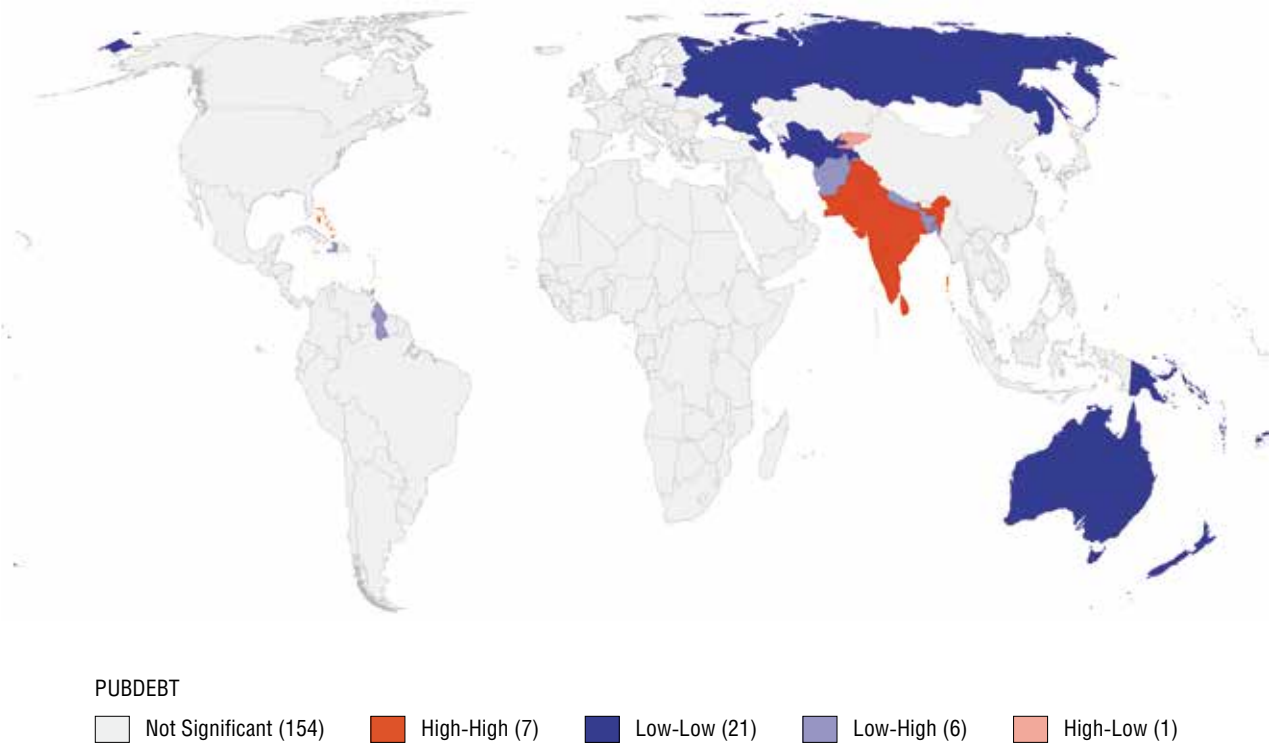


Fig. 4.3.4. “Sovereign debt” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.4. Bank deposits

The ratio of deposits in financial institutions to GDP ratio indicates, in particular, the propensity and capability of natural persons and legal entities to temporarily withdraw resources from circulation. From the point of view of banks, client deposits enable banks, among other things, to build up their liabilities in compliance with the standards set by the central bank without entering the interbank market, and to invest in other economic agents.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.134	0.001	0.139	0.000
Geary's C	0.843	0.024	0.856	0.000

This indicator's distribution is not significantly skewed: the difference between the arithmetic mean and the median across the world is approximately 9% of GDP. However, the range of values reveals major deviations from the mean in some countries both towards large accumulated funds (for instance, in Luxembourg, Lebanon and Japan) and in the opposite direction for poor countries (for example, deposits in financial institutions in Niger account for a share of GDP that is 29 times smaller than the share of deposits in Luxembourg; deposits in financial institutions in Tajikistan and the Democratic Republic of the Congo are 30 times smaller).

The percentile cartogram (Fig. 4.4.1) shows that, with the exception of most countries in Europe, North America and some East Asian states, relatively large funds are kept in the accounts of many former European colonies (for instance, in Australia, India, South Africa and Brazil) and in territories where resource-extraction companies operate (for instance, in Iran, Bolivia and Libya). Poorer savers — for example, those in Pakistan, Russia or in West Africa — have relatively small deposits.

Spatial autocorrelation calculations under both geometric and geopolitical neighbourhood matrices yield similar conclusions. These findings do not allow us to claim that the global geopolitical structure is more important than geography.

Spatial autocorrelation analysis using a geometric matrix (Fig. 4.4.3) allowed to identify two clusters with a high and one with a low share of deposits. The low-low cluster is situated in West Africa and includes Senegal, Gambia, Guinea Bissau, Sierra Leone, Mali, Liberia, Côte d'Ivoire, Burkina Faso, Gana, Togo, Benin, Niger, Nigeria, Cameroon, Gabon, Equatorial Guinea. Even though many companies in these states and their

Global place	Country	Indicator (% of the GDP)
1	Luxembourg	399.89
2	Lebanon	243.04
3	Japan	218.23
Mean (65)	(South Africa)	59.5125 (59.54)
Median (81)	China	50.95
158	Niger	13.74
159	Tajikistan	12.2
160	Democratic Republic of the Congo	8.91

governments receive revenues from extracting resources, they and their employees (and especially the rest of the poor population) cannot afford to withdraw significant amounts from circulation to form deposits.

Three other clusters of high deposits are situated in North America (Canada and the US), South America (Suriname, Guyana and some Caribbean states) and Europe. The European cluster includes most countries of Western and Northern Europe, including France, Germany, Spain, Italy, Ireland, Iceland and other states. These are developed countries with a rich banking tradition and a considerable middle class that can afford vast savings. This cluster neighbors a number of “mistakes”, where the neighborhood logic is not working. First and foremost those are the Eastern European countries (including the Ukraine, Romania, Hungary and Serbia) and the Baltic states (Latvia and Lithuania), as well as Turkey and Georgia where many households can not afford to save a considerable part of their earnings. As a result, the cartogram shows a considerable difference between Western and Eastern Europe. The United Kingdom stands out due to the tradition of financing business not through banks, but through the stock exchange in contrast with the continental tradition of most European Union members.

A high-high cluster in North America has probably appeared, because it neighbors relatively poor Latin American countries that have much lower deposits than than the rich United States and Canada. The North American cluster includes the Bahamas with an offshore regime and a developed tourist industry that allows large savings. The Dominican Republic with a low volume of deposits stands out as a “mistake” in this cluster.

The use of a geopolitical matrix (fig. 4.4.4) instead of a geometric does not drastically change the overall picture. Western and Eastern European countries once again differ by this parameter. It can be assumed that in future such countries as Lithuania, Latvia, Hungary and Rumania, which largely fall behind in terms of deposits, will increasingly depend not on internal resources, but on external funding from wealthy investors. Among the changes is the expansion of the low deposit cluster in Africa, which now includes Chad.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Bank deposits” parameter (Fig. 4.4.2) revealed similarities between Central American neighbours with small deposits. Depositors in Tropical Africa have also approximately equally modest means.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Inbound tourism	0.029	0.039	0.271	2.515
2	Number of doctors	0.072	0.001	0.317	1.387
3	Export	0.043	0.009	0.236	1.282
4	Economic inequality	0.039	0.021	-0.22	1.252
5	Import	0.036	0.02	0.206	1.190
6	IMF voting power	0.033	0.022	0.185	1.045
7	Highly wealthy population	0.060	0.004	-0.248	1.033
8	Population growth	0.055	0.003	-0.223	0.906
9	Pharmaceutical exports	0.046	0.013	0.202	0.892
10	Regional trade agreements	0.08	0.0003	0.265	0.883

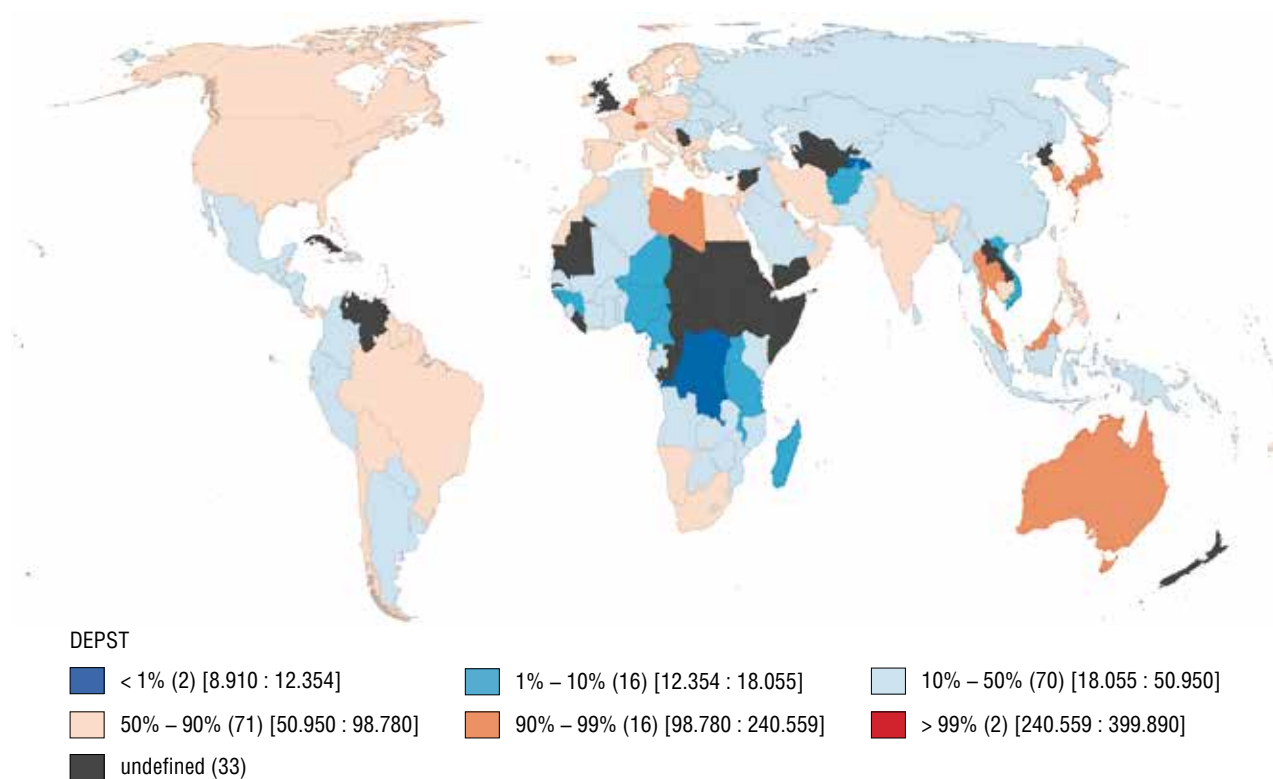


Fig. 4.4.1. Percentile cartogram for the “Bank deposits” indicator

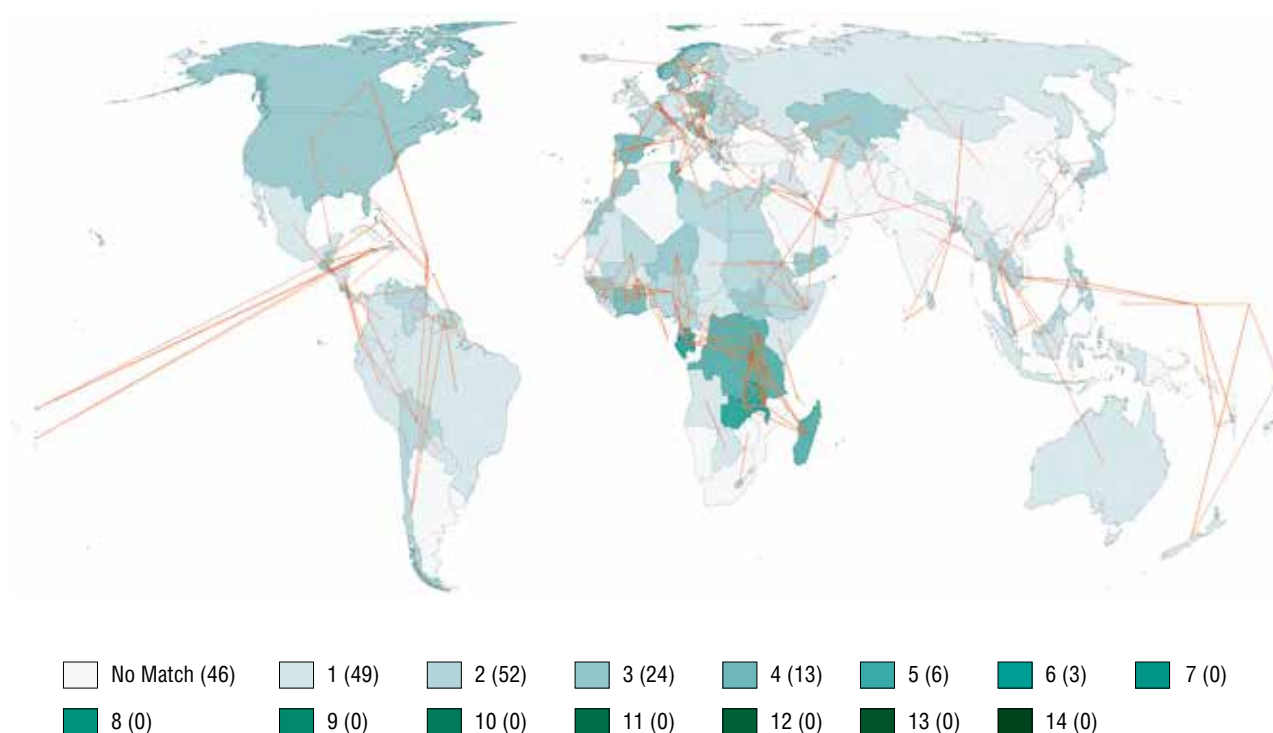


Fig. 4.4.2. Likelihood-ratio test for the “Bank deposits” parameter

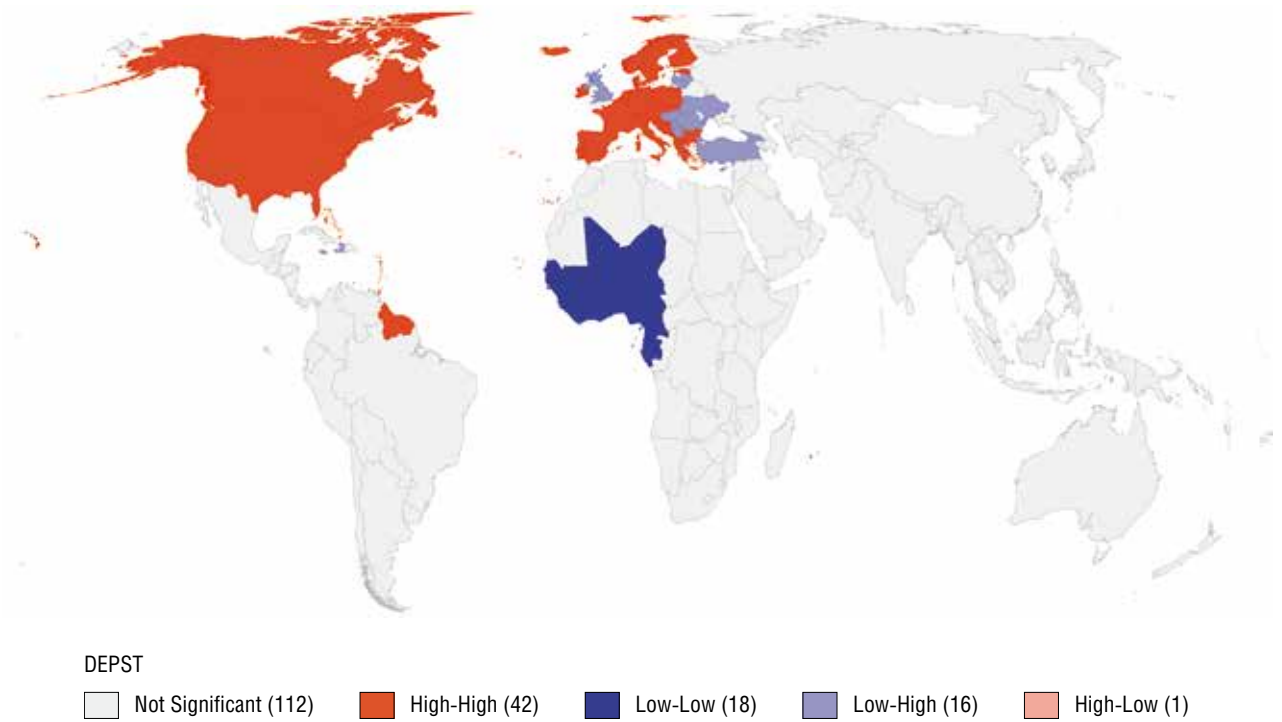


Fig. 4.4.3. “Bank deposits” spatial autocorrelation cartogram for the geometric neighbourhood matrix

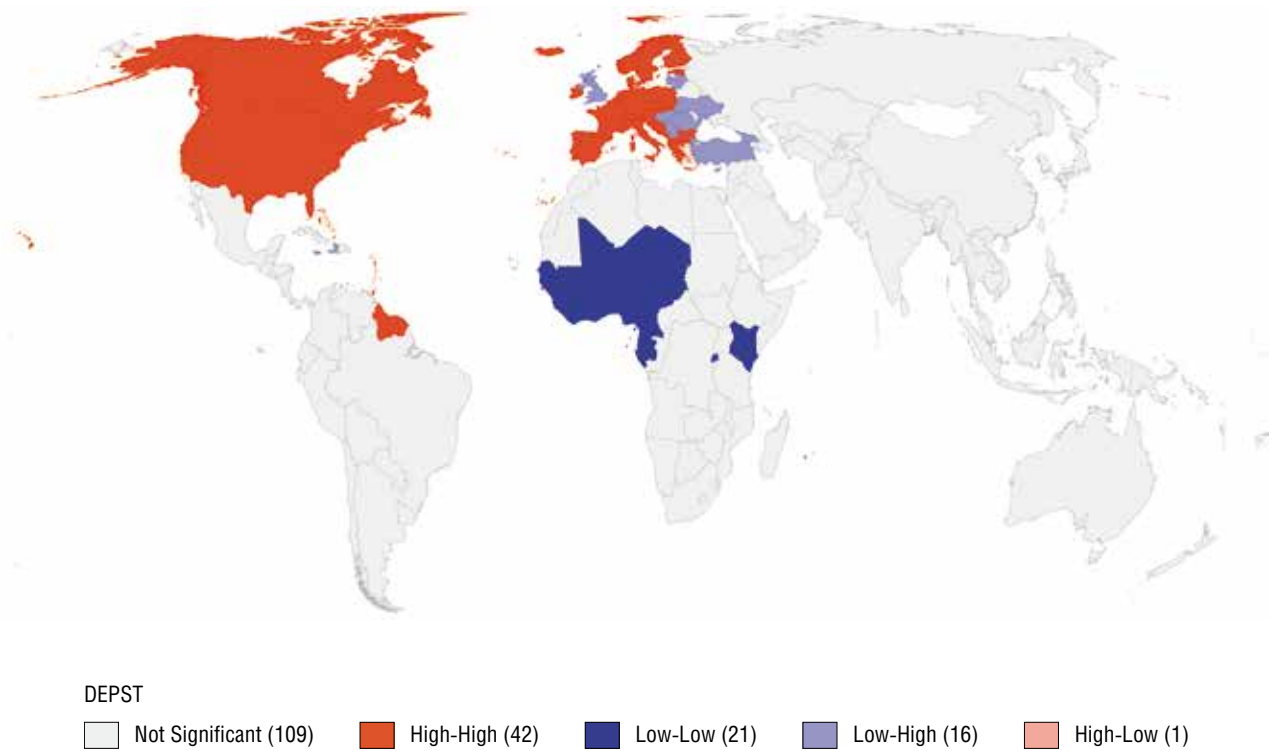


Fig. 4.4.4. “Bank deposits” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.5. Short-term consumer loans

Household access to overdrafts for short-term consumer loans was measured as the number of credit cards per 1000 population. We should note that we did not account for the amount funds available on debit cards, and we measured the right to instantaneously receive loans from banks, rather than the actual value of the loans themselves.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.158	0.000	0.165	0.000
Geary's C	0.808	0.021	0.831	0.000

This indicator is distributed in a highly uneven manner across the globe, as indicated by the difference between the mean and the median values: the mean is nearly two times greater than the median. Only 34 countries are above the mean (the population of Luxembourg has 23 times more cards per capita than the median, while Japan and Canada have ten times more; and 11 countries have more than one card per person in 11 countries), and consequently, we may state that the distribution of the frequency distribution of values is skewed towards countries where lending is not widespread. The range of values is also significant: the number of credit cards per 1000 population in Afghanistan, Madagascar and Samoa, for example, is in double or single digits.

The percentile cartogram (Fig. 4.5.1) reveals the spatial aspect of the above-mentioned skewed distribution. The lack of data for some developed countries does not preclude us from stating that many citizens with access to loans from banks live in developed or new industrial countries. It is likely the size of secondary and tertiary sectors of the economies of these countries that allows the people to have sufficient income for banks to consider them solvent and issue them a credit card.

Spatial autocorrelation calculations under both geometric and geopolitical neighbourhood matrices yield similar conclusions. These findings do not allow us to claim that the global geopolitical structure is more important than geography.

The first spatial autocorrelation cartogram (Fig. 4.5.3) records the widespread use of credit cards in Portugal and South Korea and the surrounding countries. Both are highly developed countries with a

Global place	Country	Indicator (per 1,000 population)
1	Luxembourg	4,199.51
2	Japan	2,519.1
3	Canada	2,056.24
Mean (35)	(Kazakhstan)	370.4428 (365.38)
Median (58)	Latvia	184.28
114	Afghanistan	0.09
115	Madagascar	0.02
116	Samoa	0

stable economy and a rather high population income (which increases the lending market's capacity from the point of view of risk managers at banks) and are located next to the solvent population of other countries.

The population of countries with an underdeveloped economy, mass employment in low-income sectors and prevailing poverty, primarily in Africa south to Sahara, does not widely use credit cards. These features mean that banks may, instead of approving a credit limit for their clients, issue debit cards for them, and debit cards are not accounted for in the statistics. In addition to the above-mentioned factors that are conducive to low solvency, we should note that these countries have large rural populations that rarely pay for purchases over the internet, live far away from ATMs (or points of sales in their localities have unreliable connections with banks payment centres), and are also wary of financial innovations.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 4.5.4) draws attention to a gap in access to consumer lending between the populations of Western and Eastern Europe. Credit cards are more widespread in western countries (including Canada), which may be explained by the fact that people there have a more positive opinion of credit relations, and that the Eastern European lending market is smaller, which, according to the banks in the region, is due to the large number of insolvent people living there. Additionally, this method confirms the homogeneity of South-East Asia for this parameter, likely because of the low borrowing capacity of most people.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Short-term consumer loans" parameter (Fig. 4.5.2), just like the autocorrelation under the geopolitical matrix, shows that Eastern Europeans have fairly equal (at the country analysis level) access to short-term loans. Low and similar indicator values in South and Southeast Asia are likely due to the specific means of collecting statistics. The active penetration of mobile payments and loans means that reports on credit cards distort the overall picture of loan accessibility.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Budget deficit	0.050	0.048	0.234	1.102
2	Number of doctors	0.100	0.001	0.313	0.978
3	Motorways	0.041	0.029	0.189	0.867
4	Primary school dropouts	0.058	0.013	-0.219	0.828
5	Bioethical freedom	0.074	0.004	0.217	0.634
6	Railway network	0.093	0.003	0.242	0.633
7	Access to electricity	0.079	0.002	0.219	0.606
8	FDI income	0.129	0.000	0.278	0.597
9	Royalties to foreign copyright holders	0.049	0.026	0.171	0.593
10	R&D spending	0.205	0.000	0.344	0.578

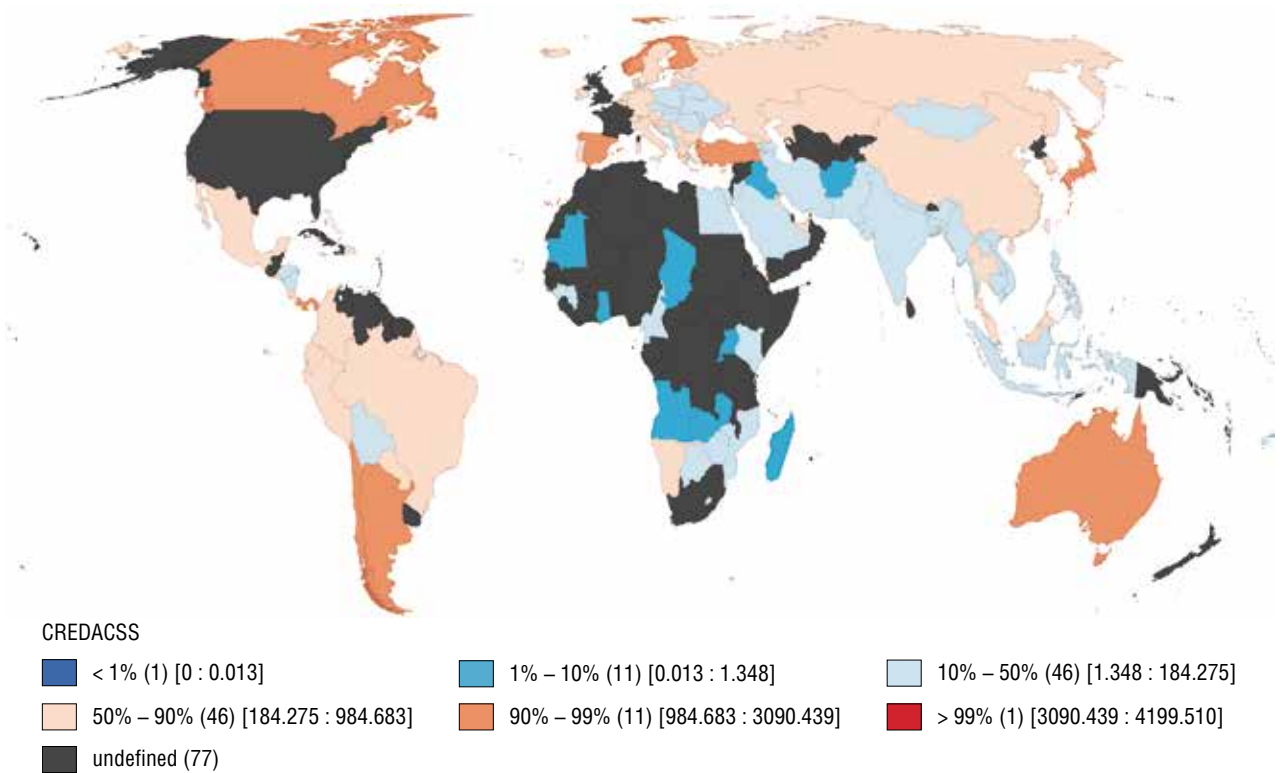


Fig. 4.5.1. Percentile cartogram for the “Short-term consumer loans” indicator

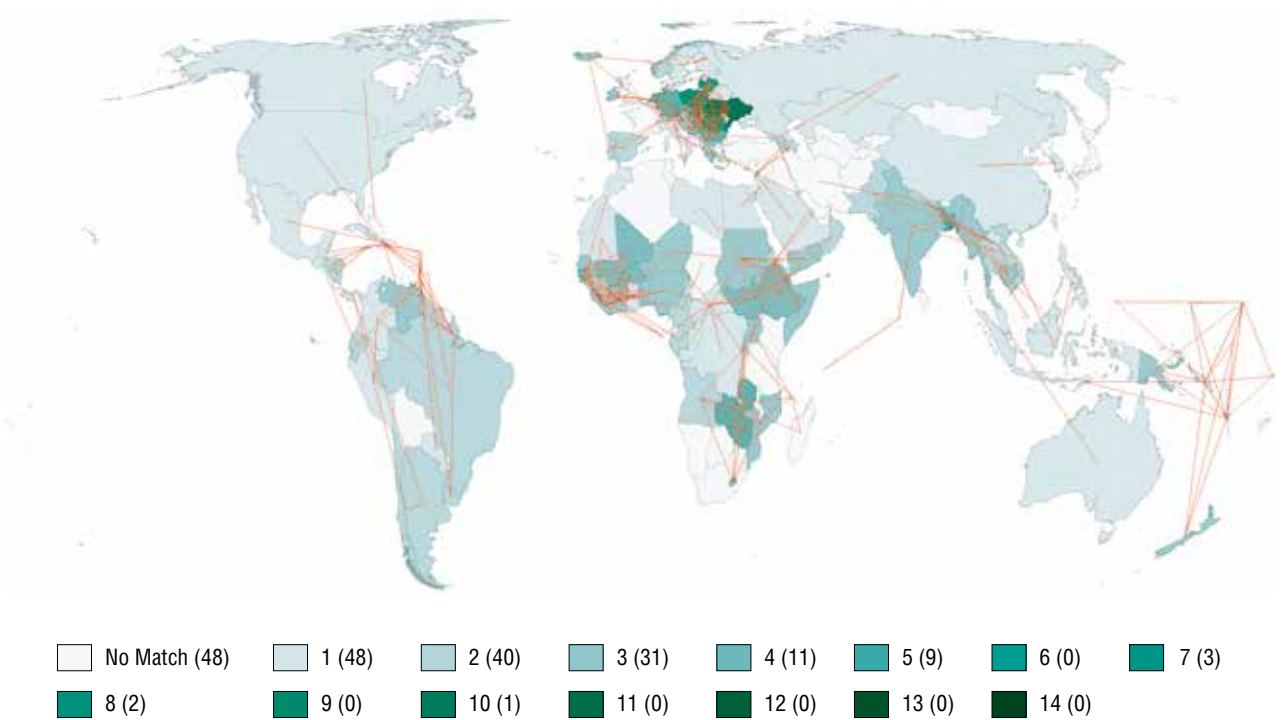


Fig. 4.5.2. Likelihood-ratio test for the “Short-term consumer loans” parameter

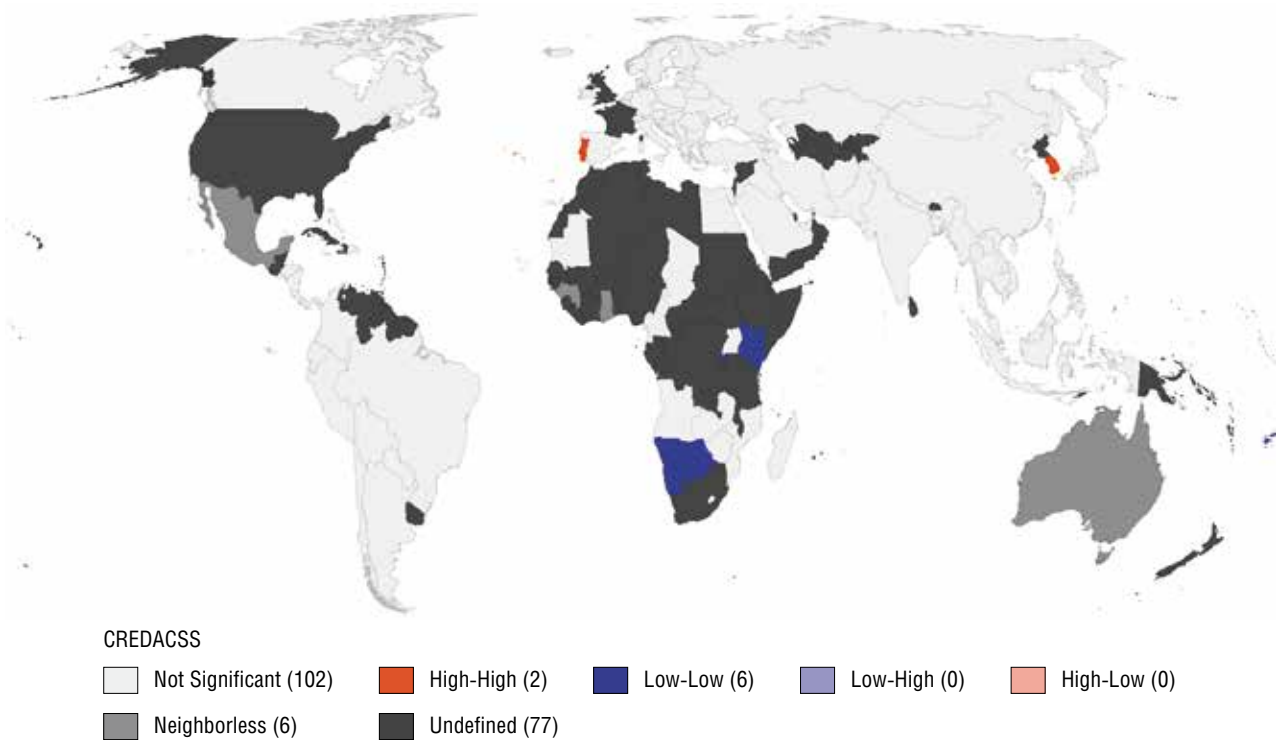


Fig. 4.5.3. “Short-term consumer loans” spatial autocorrelation cartogram for the geometric neighbourhood matrix

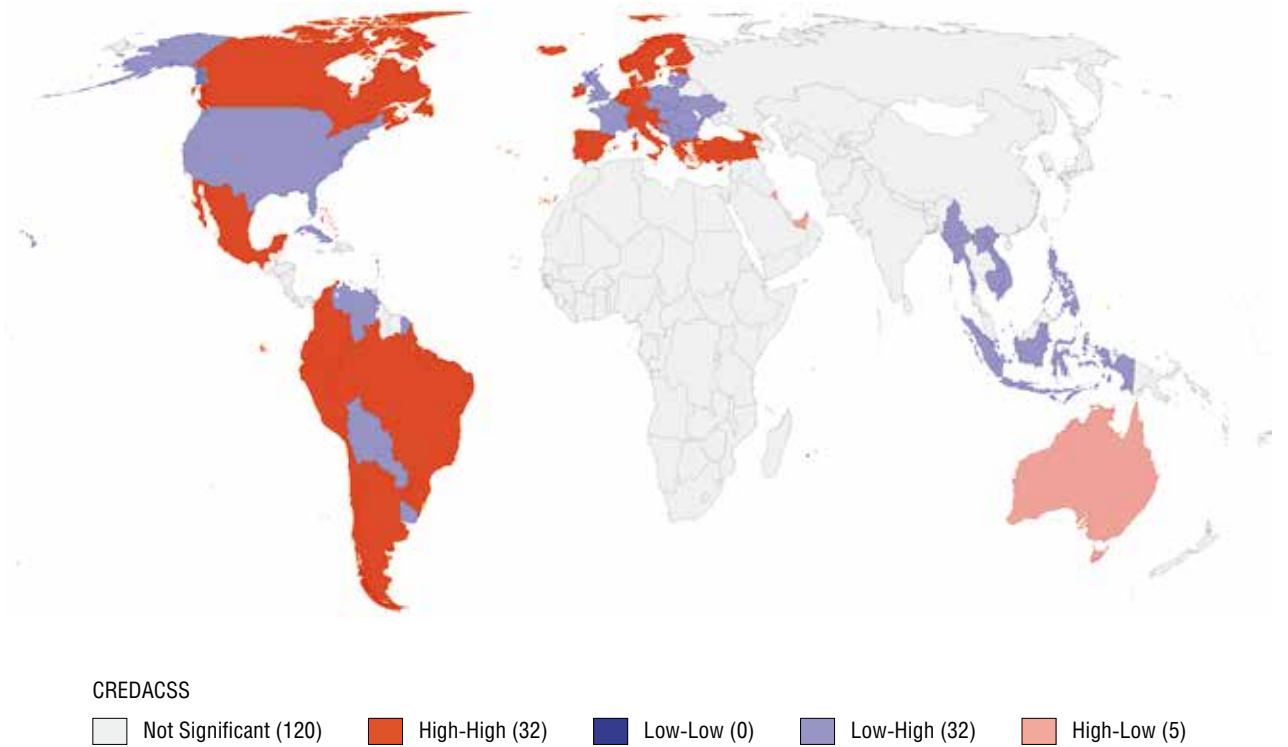


Fig. 4.5.4. “Short-term consumer loans” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.6. Loans to domestic companies

Lending volume shows how much banks and enterprises use one of the tools to accelerate economic activities. In order to demonstrate this form of economic relations, we confined the ratio of accumulated borrowings of non-financial institutions to GDP in 2018 to loans by entities located in the same country as the lending bank.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.335	0.000	0.220	0.000
Geary's C	0.666	0.000	0.776	0.000

Bank lending in most countries is below the global mean. However, 20 or so countries fit between the mean and the median. There are only six countries where loans taken out prior to 2018 exceeded 1.5 times GDP; the figure exceeds 100% of GDP for 23 countries. The lowest value is also rather far removed from the mean.

The percentile cartogram (Fig. 4.6.1) shows that lending is widespread not only in the Global North, but also in the former European colonies. Lending has become commonplace in Brazil, Chile and South Africa, for example, alongside the capitalist principles introduced by the colonial powers.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The Western European cluster on the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 4.6.3) includes countries with large banks and many solvent borrowers: France, Belgium, Germany and the states of Northern Europe. The Republic of Ireland exhibits low loan volumes and may thus stand out from this cluster because many Irish companies, unlike their counterparts in continental Europe, attract additional funds on the capital market instead of from banks.

Canada, South Korea and most countries in their respective regions also have solid banking systems and large-capacity lending markets. Another cluster is formed by Vietnam and Cambodia. The support extend-

Global place	Country	Indicator (GDP %)
1	US	180
2	Switzerland	174.6
3	Japan	169.4
Mean (69)	(Saudi Arabia)	53.9545 (54)
Median (89)	(Paraguay)	43.9 (43.8)
174	Yemen	5.6
175	Afghanistan	3.3
176	South Sudan	2.3

ed by local financial institutions to businesses in Vietnam is likely to be mostly stimulated by the government's policy.

Countries in the large African low-value cluster have few solvent borrowers and large banks that lend massively to local enterprises. This group includes the Comoros, Mozambique, Malawi, Zambia, Angola, Tanzania, Kenya, Uganda, Rwanda, Burundi, the Democratic Republic of the Congo, Sudan and South Sudan, the Central African Republic, Congo, Sudan, South Sudan, the Central African Republic, the Congo, Gabon, Equatorial Guinea, São Tomé and Príncipe, Cameroon, Nigeria, Chad, Niger, Senegal, Côte d'Ivoire, Liberia, Sierra Leone, Guinea, Guinea Bissau and Djibouti. Another country with a low value of the local indicator of spatial association is Uzbekistan, but it does not form a cluster with the current level of statistical mistake.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 4.6.4) shows that these countries are contrasted with South Africa and Namibia whose wealthier populations maintain the solvency of local borrowing companies. The shortage of enterprises that are capable of instilling confidence in a bank may explain the visible difference between Eastern European countries and the Western European cluster. Companies in some countries of South-East Asia including Myanmar, Laos, Indonesia, the Philippines and Brunei, take out small loans compared to the enterprises of their region.

Most states where lending is just as widespread as in their region as a whole stimulate economic activity by keeping the central bank's key interest rate low. This gives commercial banks access to cheap loans, which thus reduces interest rates for clients. Countries with stable currencies and low inflation that can be controlled by raising the key interest rate (the United States, Canada, Japan and the Eurozone countries) are not the only ones following this policy. It should be noted that the data analysed refer to year 2018, when the Chinese economy had not yet experienced the risks of overheating, and Turkey's national currency had not yet started to lose its value.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Loans to domestic companies" parameter (Fig. 4.6.2) emphasized the similarities between Central American countries with moderate lending penetration. Additionally, the homogeneity of the African continent in terms of this indicator is confirmed.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	Two-factor Moran's I	P-value	Spatial effect index
1	Economic inequality	0.040	0.013	-0.250	1.525
2	Highly wealthy population	0.055	0.004	-0.276	1.373
3	Ethnic fractionalization	0.08	0.001	-0.282	0.991
4	Linguistic diversity	0.074	0.000	-0.269	0.974
5	Cultural solidarity	0.045	0.008	0.202	0.901
6	Ethnic minorities	0.048	0.005	-0.207	0.885
7	Particulate air pollution	0.148	0.000	-0.346	0.810
8	Number of doctors	0.199	0.000	0.378	0.719
9	Women in politics	0.041	0.007	0.171	0.709
10	Population growth	0.116	0.000	-0.287	0.709

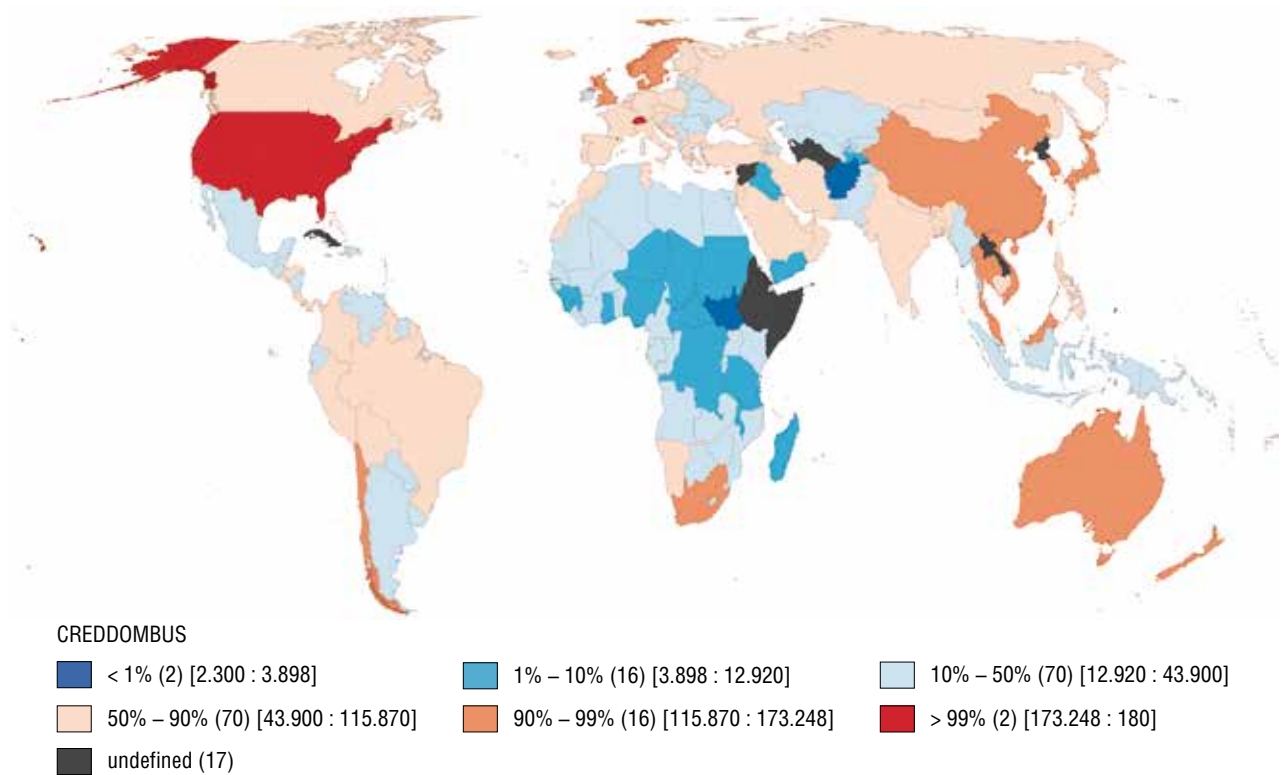


Fig. 4.6.1. Percentile cartogram for the “Loans to domestic companies” indicator

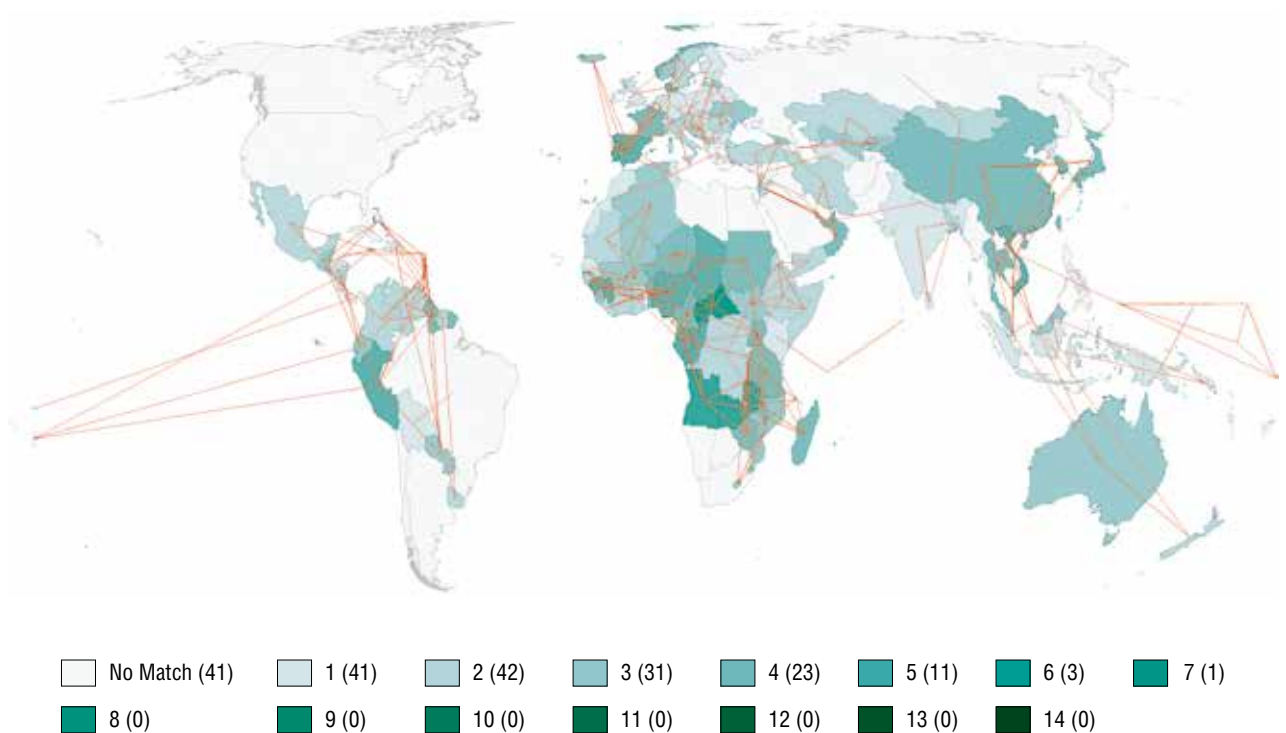


Fig. 4.6.2. Likelihood-ratio test for the “Loans to domestic companies” parameter

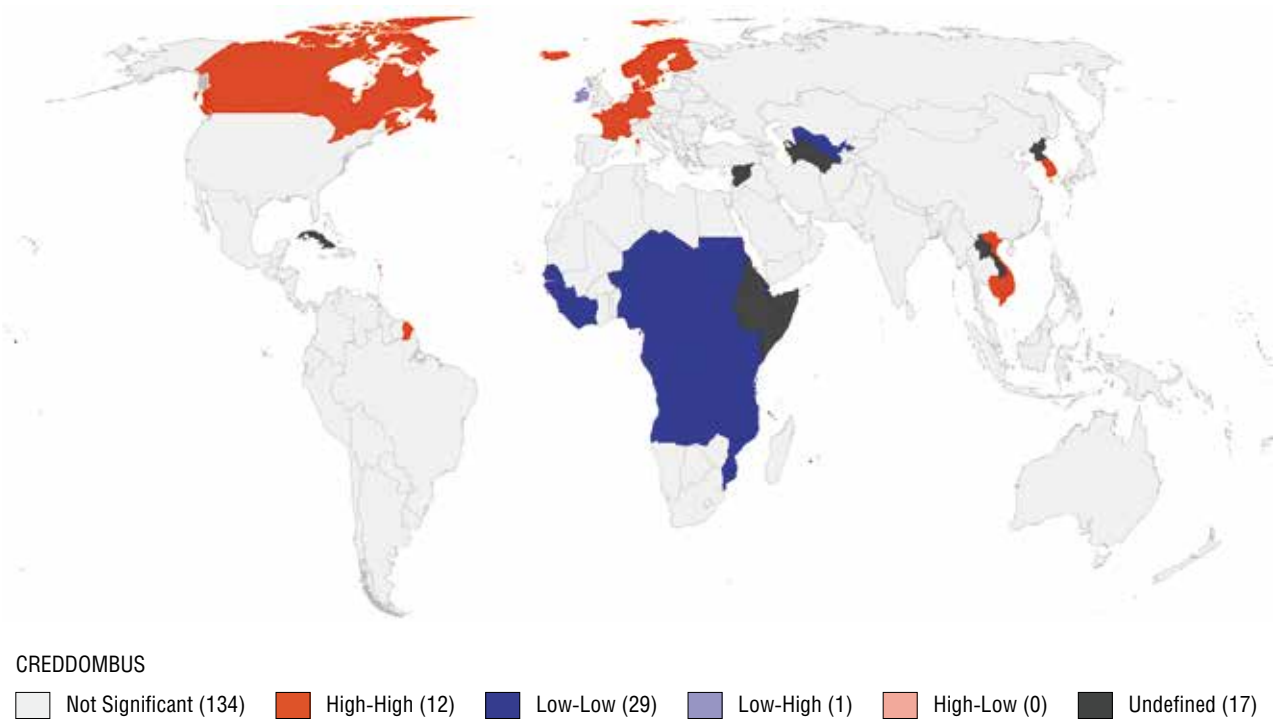


Fig. 4.6.3. “Loans to domestic companies” spatial autocorrelation cartogram for the geometric neighbourhood matrix

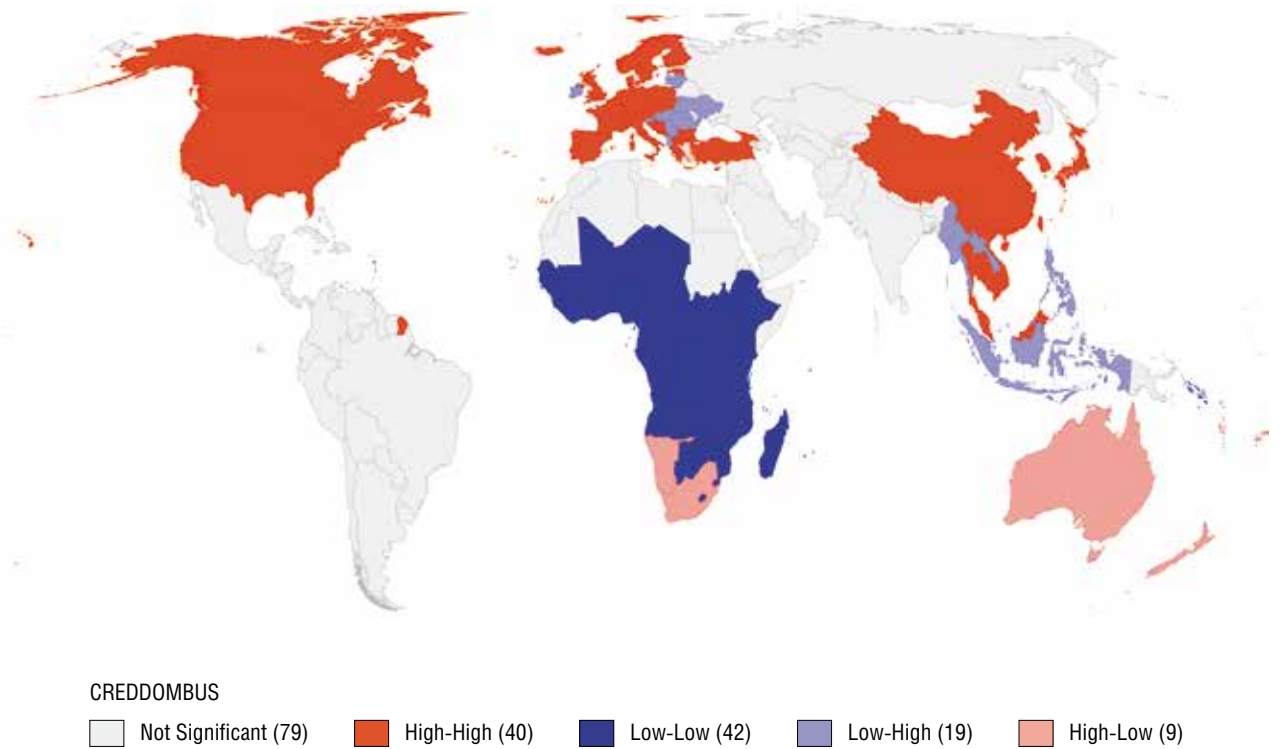


Fig. 4.6.4. “Loans to domestic companies” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.7. Foreign assets

This World Bank indicator measures accumulated loans issued to foreign clients and thus shows how willing a country's banks are to run the risks involved in cross-border transactions and how stable they are to be able to do so. Borrower solvency is particularly important when lending to foreign enterprises, and especially to natural persons, since collecting an outstanding debt in such circumstances is difficult.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.097	0.001	0.062	0.000
Geary's C	0.893	0.257	0.933	0.000

The distribution of this indicator throughout the world is highly uneven, as indicated by the twofold difference between the mean and the median. Banks in most countries are not particularly active on foreign markets in this way. At the same time, there are 14 states with values from 100% to 170% of their GDP (Luxembourg and the Bahamas are not included here, as they have anomalously high foreign assets percentages). These countries include the Czech Republic, Finland, New Zealand, the United Kingdom and Belgium, whose banks can lend funds to foreign parent companies as they often have numerous subsidiaries in those territories (and consequently may serve as collateral for loans and may be seized in the event that a borrower goes bankrupt).

The percentile cartogram (Fig. 4.7.1) records high values for this parameter in various regions, but most frequently in Europe and Central and North America, which are saturated with highly developed economies and offshore zones. The foreign assets of many Asian and African countries are relatively small.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram (Fig. 4.7.3) shows that African financial institutions have relatively few foreign assets. Consequently, Algeria, Niger, Kenya, Zambia and Angola are mostly surrounded by states with similarly low values. These are countries with weak economies and un-stable financial systems where

Global place	Country	Indicator (% of the GDP)
1	Luxembourg	1,170.3
2	Bahamas	428.4
3	Belize	169.5
Mean (37)	(Germany)	48.6361 (48.5)
Median (67)	El Salvador	21.8
131	Libya	0.8
132	Democratic republic of the Congo	0.7
133	Rwanda	0.5

banks find it difficult to earn sufficient capital to regularly invest abroad. The situation among India's neighbours is similar, likely because of the large capacity of its domestic lending market, which may cause banks to prefer to service Indian clients instead of launching risky operations on foreign markets. The same is true for China that until lately had received more funding from abroad than invested abroad.

Additionally, this method emphasized a cluster of countries with active banks. Offshores with special privileges in terms of operations involving foreign assets (due the international nature of this activity) are clustered on the Caribbean islands. Since some offshore territories are also located in Oceania and Europe, the activities of their banks affect comparisons of their indicators with those of neighbouring countries. For instance, Australia's developed banking system stands out here, as does Fiji (which is also less stable politically, and this fact prevents local banks from growing to the size of transnational banks).

There is a cluster of countries active on foreign lending markets that includes the Netherlands, Belgium, Ireland and France. As foreign companies (primarily American) expand their presence in the first three countries, the capital of Dutch, Belgian and Irish banks is becoming more tightly intertwined with the assets of the firms located in those territories.

Calculations of spatial autocorrelation under the geopolitical neighbourhood matrix (Fig. 4.7.4) show the difference between the indicator values of this cluster's countries and the indicator values of less developed banking systems (for instance, those of Greece), and also of countries outside the Eurozone (in particular, Ukraine, Georgia, North Macedonia, Montenegro and Turkey). The United states with large populations that form a sizable domestic lending market also stand out compared to its neighbours: many American and Canadian banks find it profitable to focus on servicing local clients instead of foreign ones.

The similarity of Caribbean offshores in terms of high values for this parameter is further demonstrated by a likelihood-ratio test for geometric and geopolitical neighbourhood for the "Foreign assets of banks" parameter (Fig. 4.7.2). Uniformly low values, on the contrary, are identified in East Africa.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Elderly population	0.04	0.021	0.249	1.548
2	Secondary education enrolment	0.037	0.034	0.229	1.404
3	Motorways	0.042	0.019	0.216	1.121
4	Petrol prices	0.042	0.017	0.195	0.895
5	Quality of school education	0.071	0.002	0.220	0.682
6	Particulate air pollution	0.049	0.012	-0.177	0.643
7	FDI income	0.064	0.006	0.207	0.670
8	Life expectancy	0.080	0.001	0.225	0.632
9	Healthcare spending	0.127	0.000	0.277	0.604
10	Regional trade agreements	0.102	0.0002	0.248	0.602

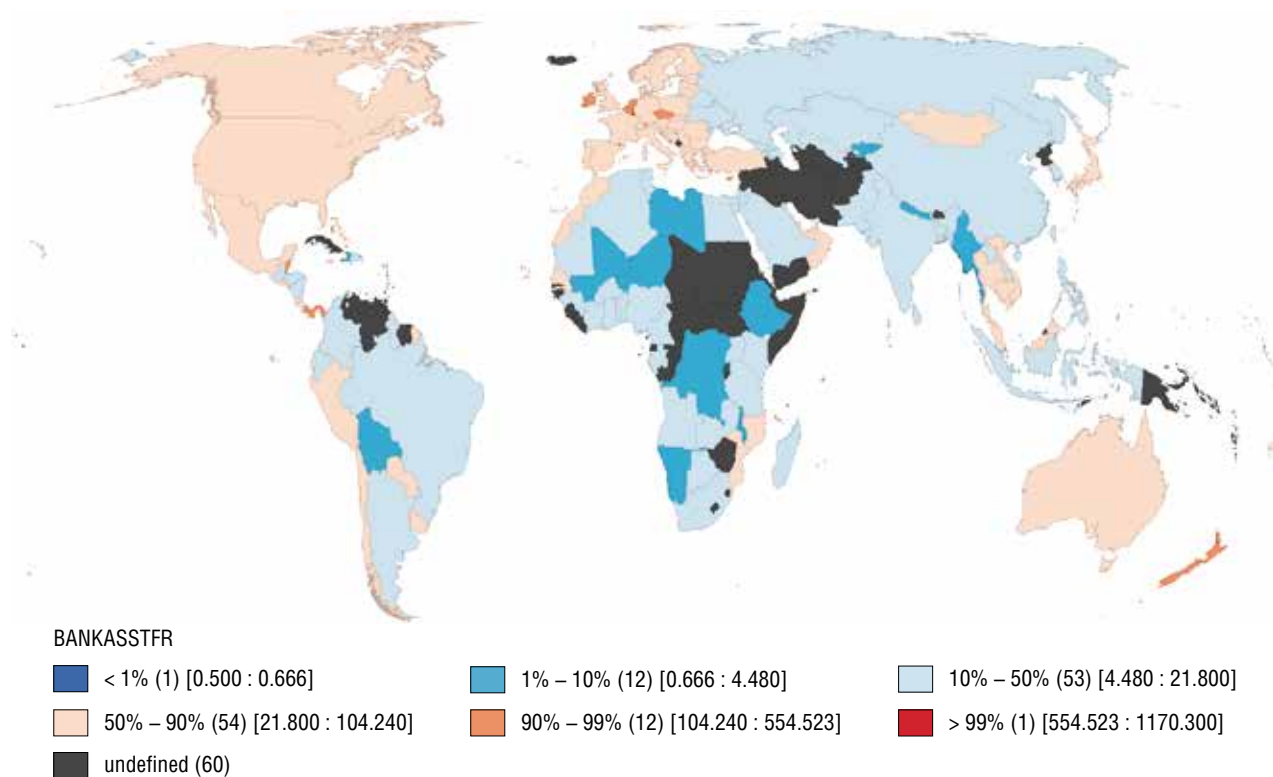


Fig. 4.7.1. Percentile cartogram for the “Foreign assets” indicator

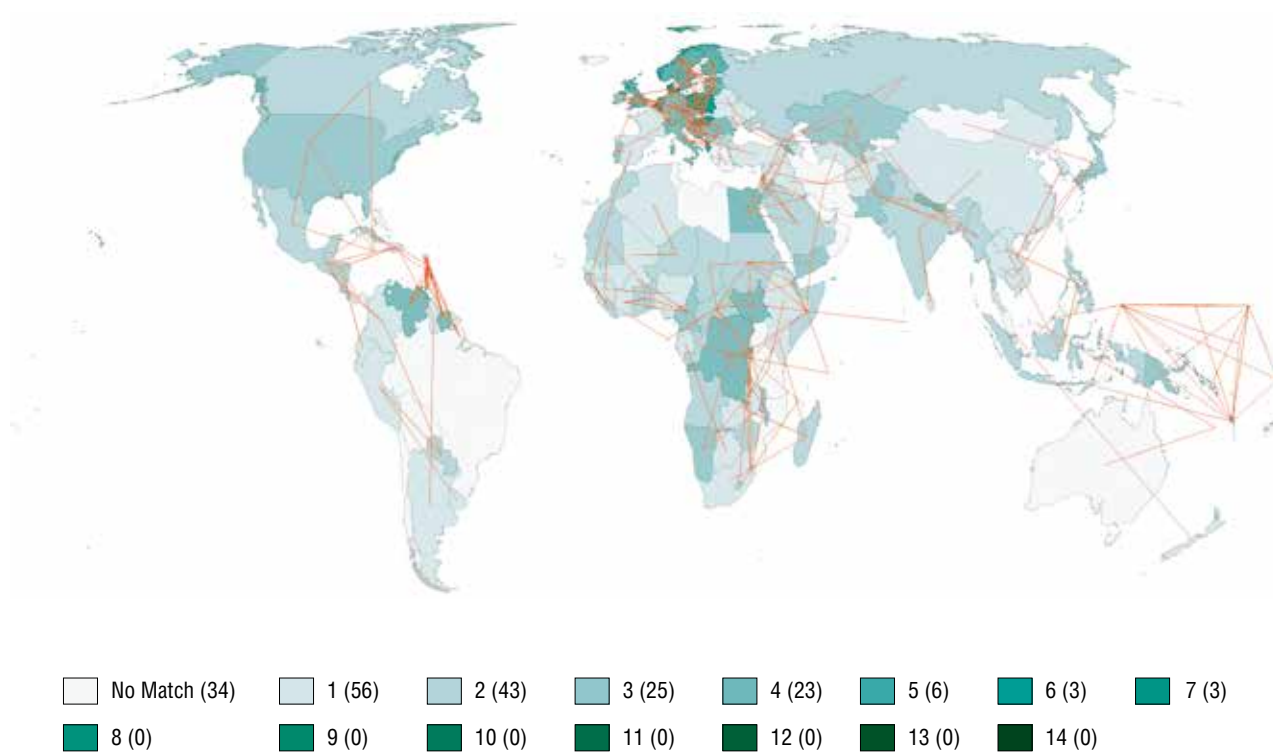


Fig. 4.7.2. Likelihood-ratio test for the “Foreign assets” parameter

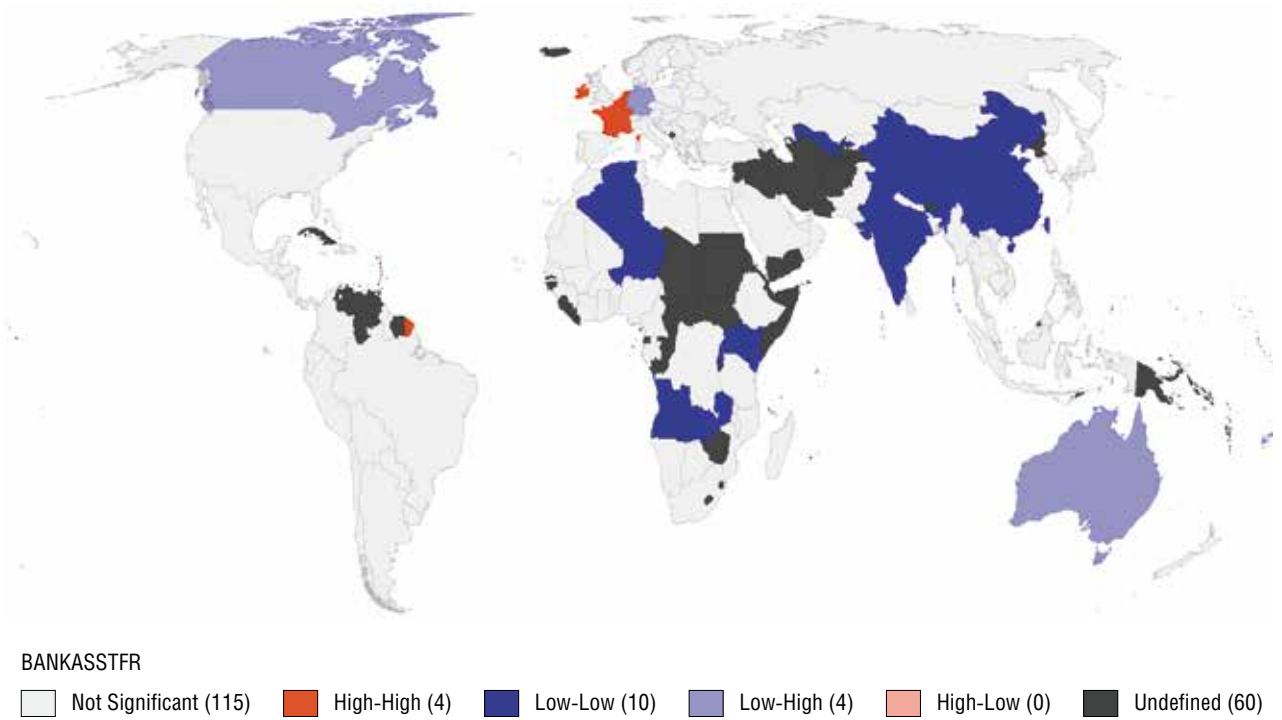


Fig. 4.7.3. “Foreign assets” spatial autocorrelation cartogram for the geometric neighbourhood matrix

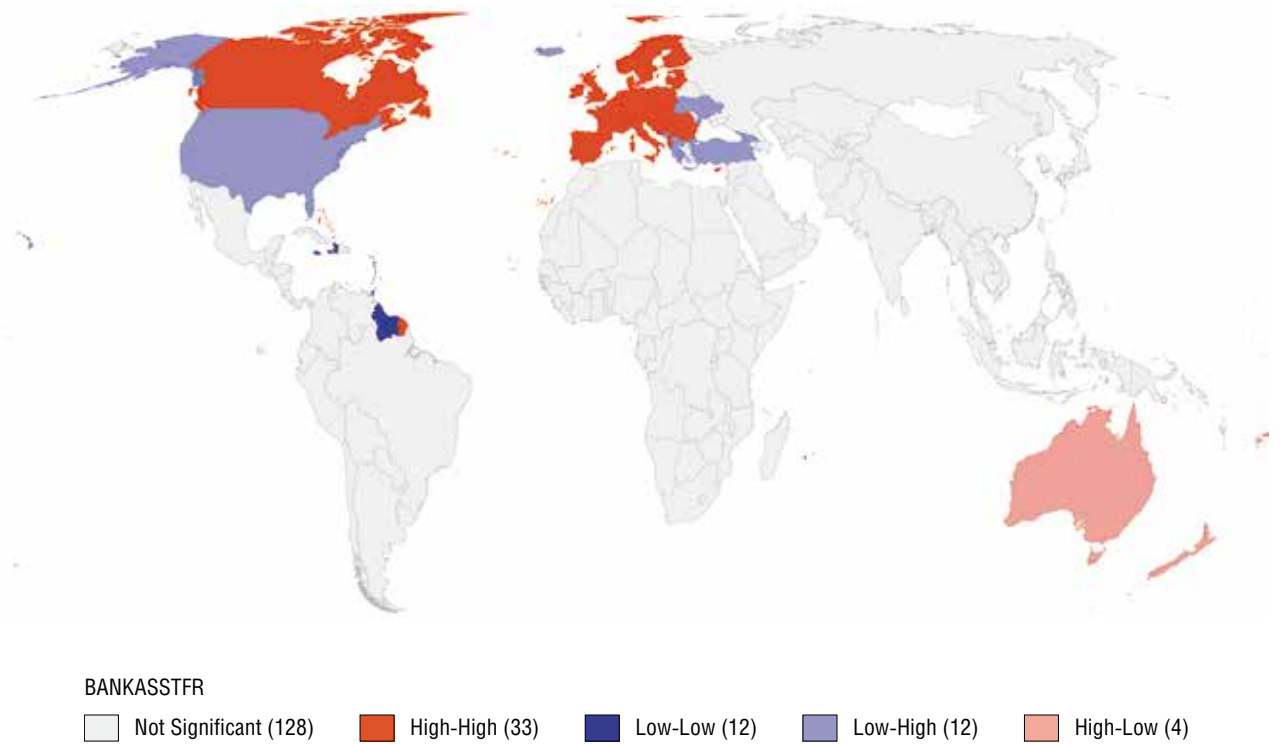


Fig. 4.7.4. “Foreign assets” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.8. Inward FDI debt stocks

This indicator measures funds provided for local companies from abroad in various forms similar to debt obligations: from payments for securities as re-purchase agreements (buyback) to deferred payments for goods. In any case, just like FDI, this money is only available for enterprises that inspire confidence in foreign investors.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.251	0.000	0.073	0.001
Geary's C	0.642	0.002	0.922	0.001

This value demonstrates highly unequal distribution by country. It is skewed towards countries with minimum values: foreign investors trust only 18 countries with amounts above the global mean. The maximum amount of resources of this type exceeds USD 1 trillion, as in the Netherlands and the United States.

China's low indicator stands out on the percentile cartogram (Fig. 4.8.1). Its enterprises can replace foreign loans with other types of financing: using funds from the developed domestic capital market or by issuing stock available for purchase by those same foreign investors. At the same time, developed countries, other BRICS members, and former European colonies that are not named here (for instance, Argentina) actively use debt instruments.

The geometric neighbourhood matrix yields a spatial correlation that is three times higher than the correlation yielded by the geopolitical matrix, and consequently, the hypothesis that the world's geopolitical structure has greater significance is not confirmed.

The spatial autocorrelation cartogram shows (Fig. 4.8.3) that countries with anomalously high indicator values are clustered in Western Europe and North America. The reputations of France, Belgium, the Netherlands, Germany and Canada on the global financial market open up massive borrowing opportunities for them.

Global place	Country	Indicator (USD million)
1	Netherlands	1,158,532
2	US	1,040,759
3	Luxembourg	680,998
Mean (19)	(Poland)	43,631.9339 (44,944)
Median (61)	Madagascar	3,997
118	Dominica	3
119–120	Marshall Islands, Kiribati	2
121	Guyana	0

The island states of the Caribbean and Oceania, as well as the Seychelles, have few large capital-intensive manufacturing enterprises, so local companies (for instance, prosperous small- and medium-sized tourist agencies) are not ready to use large borrowed funds and guarantee a stable high interest rate. As for financial institutions in the Caribbean, they rarely are short of working capital since they service offshore accounts.

Cameroon, which is specially marked on the cartogram, boasts industrial and extracting companies. However, it is impossible to borrow funds there due to mistrust of foreign investors and the low quality of life of local consumers (they could have made profits for the companies and thus help them pay off their investors).

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 4.8.4) shows high density of “crisscrossing” cross-border debt investment in the west of the Euro-Atlantic region: companies frequently finance projects in those countries to whose businesses they already own money. At the same time, companies in most post-communist countries and Turkey find it difficult to convince potential investors of their reliability.

The economies of Guyana and Suriname are not capable of digesting large volumes of investment. Additionally, they practice other forms of financing their extracting industry, for instance, joint ventures, selling company shares and issuing stock.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Inward FDI debt stocks” parameter (Fig. 4.8.2) showed that many states of Latin America and South and Southwest Asia are located among countries with similar (low) values.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	Two-factor Moran’s I	P-value	Spatial effect index
1	Pharmaceutical exports	0.037	0.045	0.286	2.221
2	Availability of electricity	0.045	0.02	0.211	0.981
3	Quality of education	0.080	0.002	0.275	0.943
4	Infant mortality	0.044	0.021	-0.201	0.925
5	Secondary education enrolment	0.055	0.013	0.226	0.922
6	Years at school	0.080	0.002	0.269	0.902
7	Elderly population	0.065	0.005	0.242	0.897
8	Alcohol consumption	0.041	0.026	0.191	0.879
9	Particulate air pollution	0.053	0.017	-0.209	0.827
10	Young population	0.049	0.016	-0.198	0.796

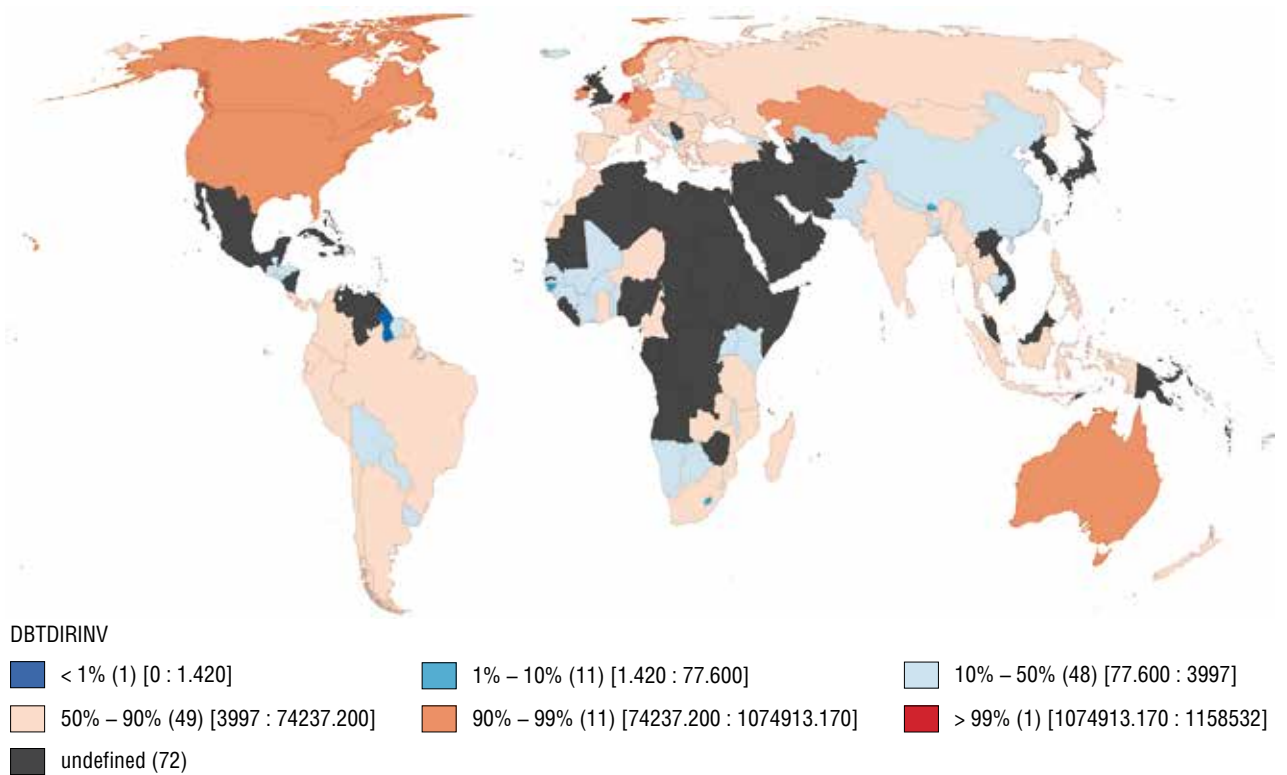


Fig. 4.8.1. Percentile cartogram for the “Inward FDI debt stocks” indicator

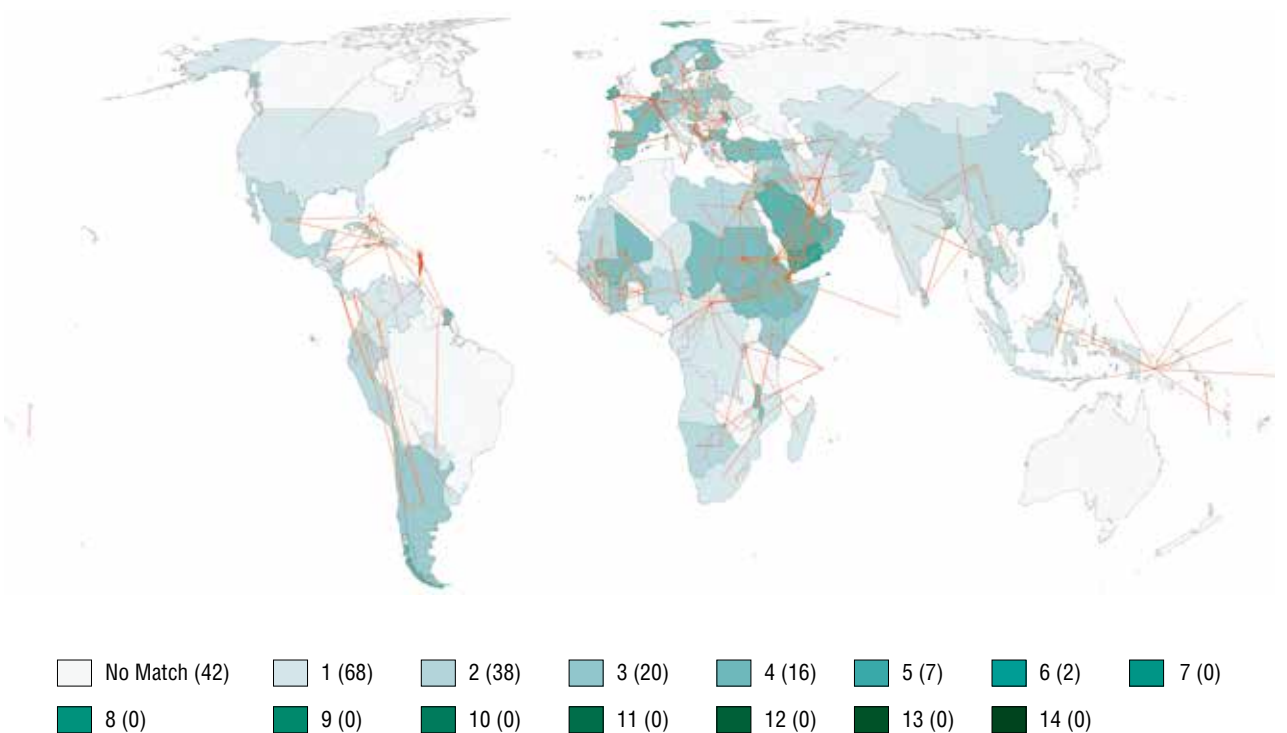


Fig. 4.8.2. Likelihood-ratio test for the “Inward FDI debt stocks” parameter

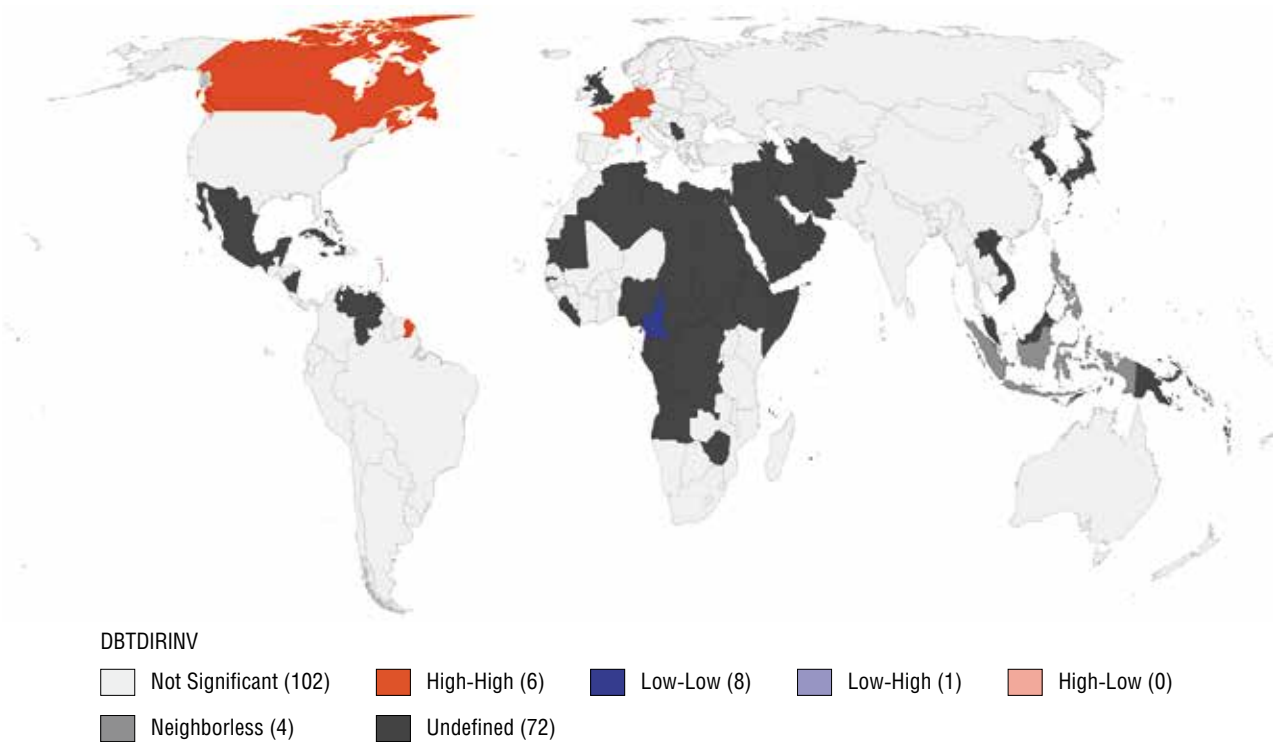


Fig. 4.8.3. “Inward FDI debt stocks” spatial autocorrelation cartogram for the geometric neighbourhood matrix

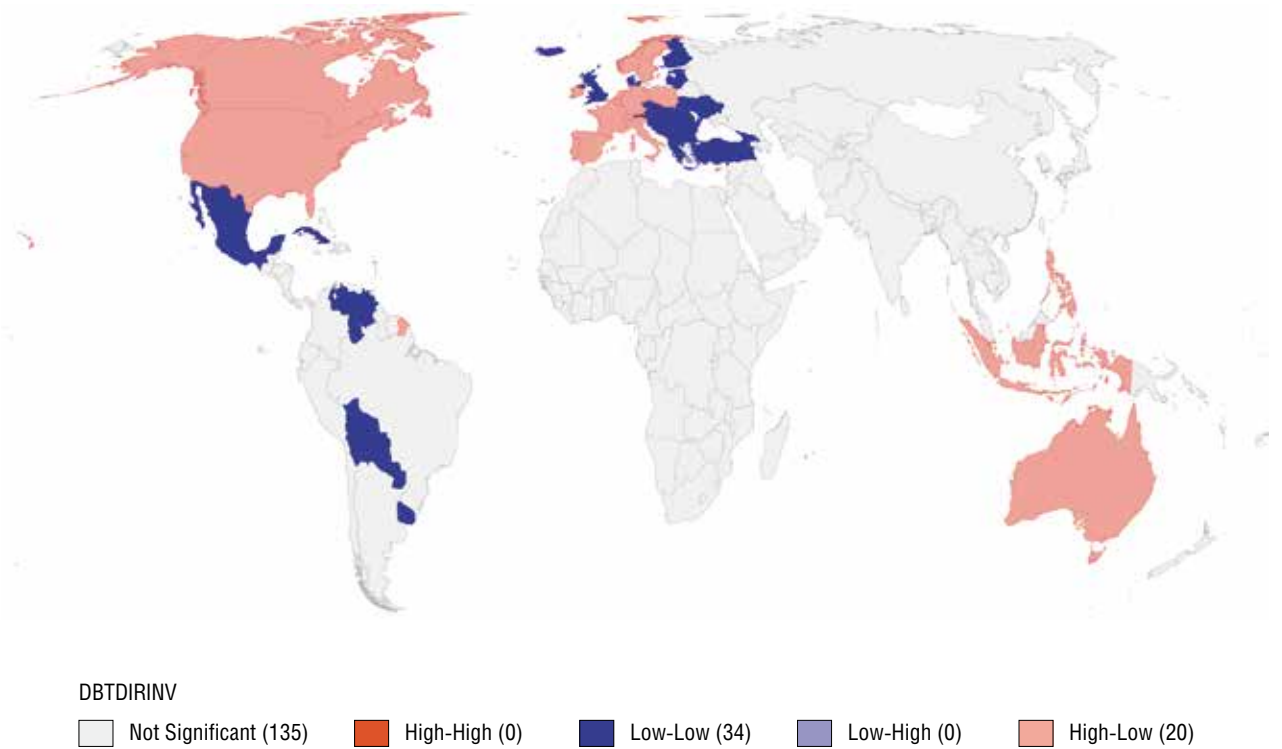


Fig. 4.8.4. “Inward FDI debt stocks” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.9. FDI inflows

We analysed money transfers from domestic enterprises to foreign investors that have priorly become interested in a country's unique features (for instance, investment climate, market capacity, or rate of return) or in specific local companies.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.264	0.000	0.089	0.000
Geary's C	0.809	0.033	0.906	0.000

This indicator manifests highly uneven worldwide distribution. The number of states that are open to cross-border financial flows and are at the same time attractive for foreign investors is small. Values from the mean to the maximum are recorded for only 32 countries, and the range of figures within the group is upwards of 17 times from smallest to largest. The frequency distribution of values is skewed towards countries that have no investment appeal or which intentionally close off their markets.

The percentile cartogram (Fig. 4.9.1) shows that foreign investors receive principal payments from maritime states (including the coast of China) and from the post-Soviet space. Of particular interest is Ghana, which is gradually becoming a regional financial centre. At the same time, many continental (particularly small) countries yield very small profit.

The geometric neighbourhood matrix yields a far greater spatial correlation than the geopolitical matrix. Consequently, it is highly unlikely that the hypothesis of the dominant significance of the world's geopolitical structure will be confirmed.

The spatial autocorrelation cartogram shows (Fig. 4.9.3) a cluster of mostly Western European countries (France, Germany, Ireland, Austria, Belgium, the Netherlands and Switzerland) that transfer large payments, since their high development level and economic stability ensure stable dividends for investors. At the same time, the international nature of these investments requires a closer analysis: frequently, businesses in this cluster (especially those with the European company status granted by the European Union) invest money within this cluster, even though officially they invest abroad, or exchange assets. Additionally, Kazakhstan and South Korea, which attract investors through the rapid development of high-margin sectors, are located among countries with similarly high values.

Global place	Country	Indicator (USD billion)
1	Netherlands	250.9
2	US	245.4
3	China	161.1
Mean (32)	(South Korea)	12.9045 (14)
Median (75–76)	Botswana, Libya	1.4
142–148	7 countries	0
149	Iceland	–0.02
150	Zambia	–0.2

Countries whose enterprises make relatively small payments are also surrounded by countries with high values. Nepal's society is fairly closed, and consequently, capital flow regulations stand in the way of large foreign investments into the country's most profitable sectors. Mongolia is rather slow in transitioning from agriculture, a sector that has little appeal for foreign investors, to the extraction industry and other economic sectors, therefore, many FDI are not particularly profitable or have not yet moved from the launch stage (for instance, purchasing mining equipment) to making profit. Even though Iceland has the status of a developed country, it did not transfer any payments abroad in 2018, apparently due to a drop in the profitability of foreign investments made shortly before a wave of bankruptcies hit Iceland's banks in 2008.

Senegal and the Gambia, as well as Tanzania on the other side of the African continent, and their neighbours are united by the small size of their domestic markets due to their poor populations: consequently, investments from foreign companies geared towards consumer demand are not particularly profitable. Fiji's location in a similar region in another part of the world is supplemented by the offshore nature of many investment projects aimed at safekeeping funds rather than payments to investors.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 4.9.4) demonstrates significant differences between mutually integrated Australia with its investments in the profitable coal industry and Oceania. Eastern European states stand out from the Euro-Atlantic cluster against the backdrop of the United States, Canada and Western European countries. It is difficult to invest large amounts in Eastern European countries (consequently, it is difficult to expect a return on investment) due to the unstable investment climate and because many local entrepreneurs are only experienced in accumulating capital and are not ready to spend large investments. Another low-value cluster can be found in Latin America, where Chile stands out by the amount of transfers to foreign investors.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "FDI inflows" parameter (Fig. 4.9.2) emphasizes compact groups of countries of the Middle East and the west of South America. Indicator values in each are fairly similar, but they are not anomalously low or high (unlike those indicated on the cartogram of local spatial autocorrelation indicators).

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Number of doctors	0.067	0.001	0.306	1.393
2	Suicide rate	0.042	0.017	0.215	1.093
3	Particulate air pollution	0.050	0.010	-0.214	0.914
4	Institutional foundations of democracy	0.043	0.011	0.186	0.806
5	Regional trade agreements	0.120	0.00001	0.306	0.779
6	Maternal mortality	0.04	0.015	-0.173	0.753
7	Access to electricity	0.039	0.015	0.166	0.705
8	Quality of education	0.143	0.000	0.310	0.672
9	Specific number of researchers	0.157	0.00003	0.323	0.662
10	Conservation areas	0.058	0.003	0.195	0.658

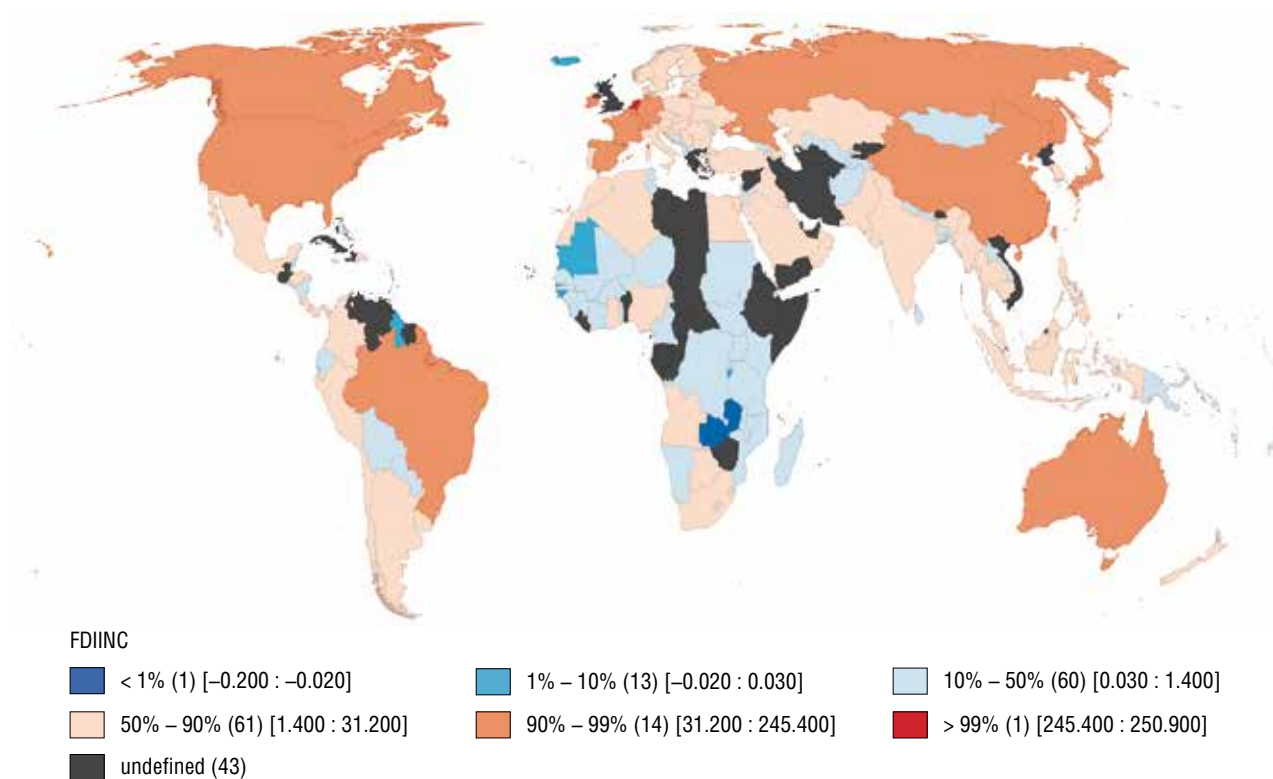


Fig. 4.9.1. Percentile cartogram for the “FDI inflows” indicator

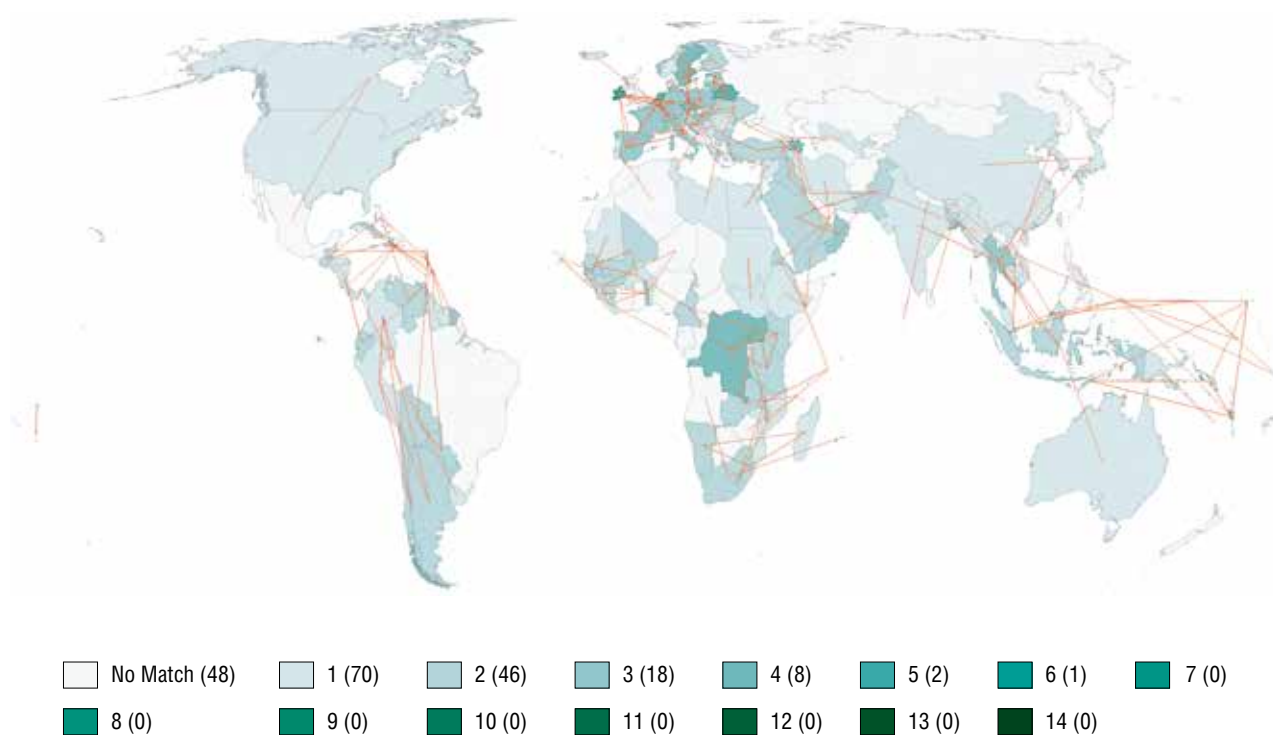


Fig. 4.9.2. Likelihood-ratio test for the “FDI inflows” parameter

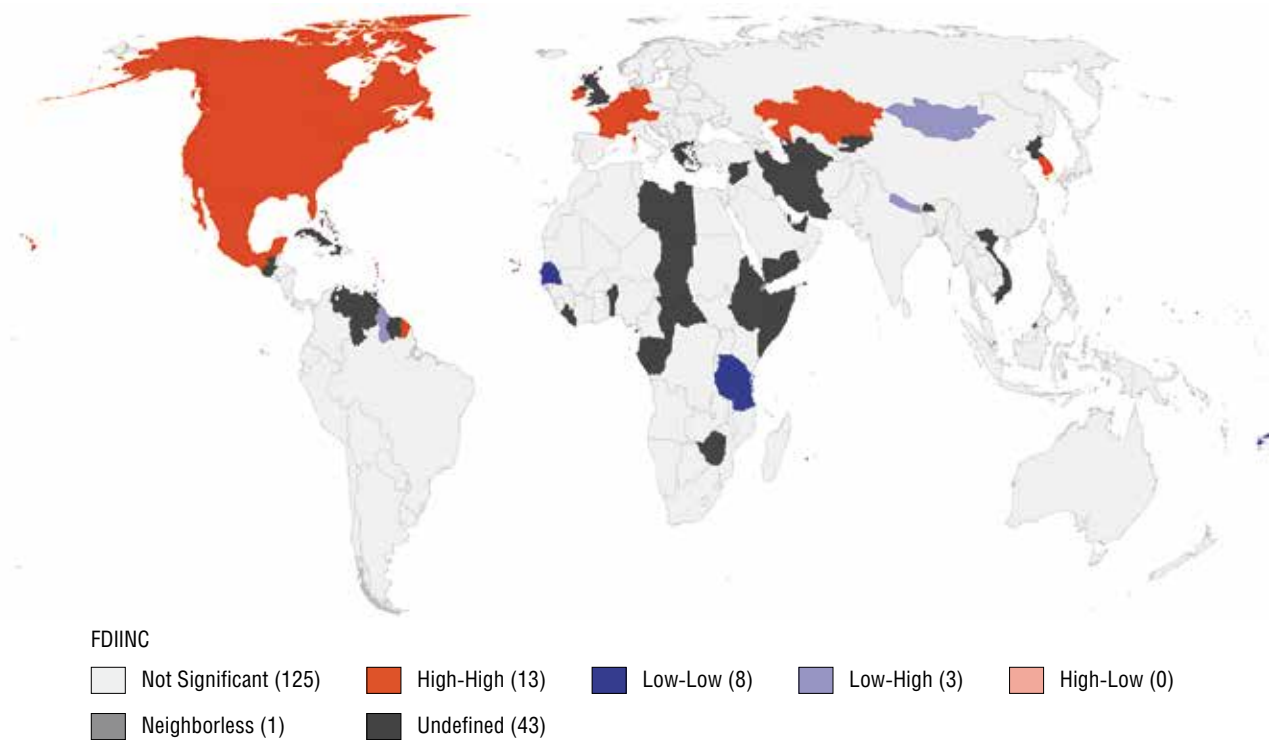


Fig. 4.9.3. “FDI inflows” spatial autocorrelation cartogram for the geometric neighbourhood matrix

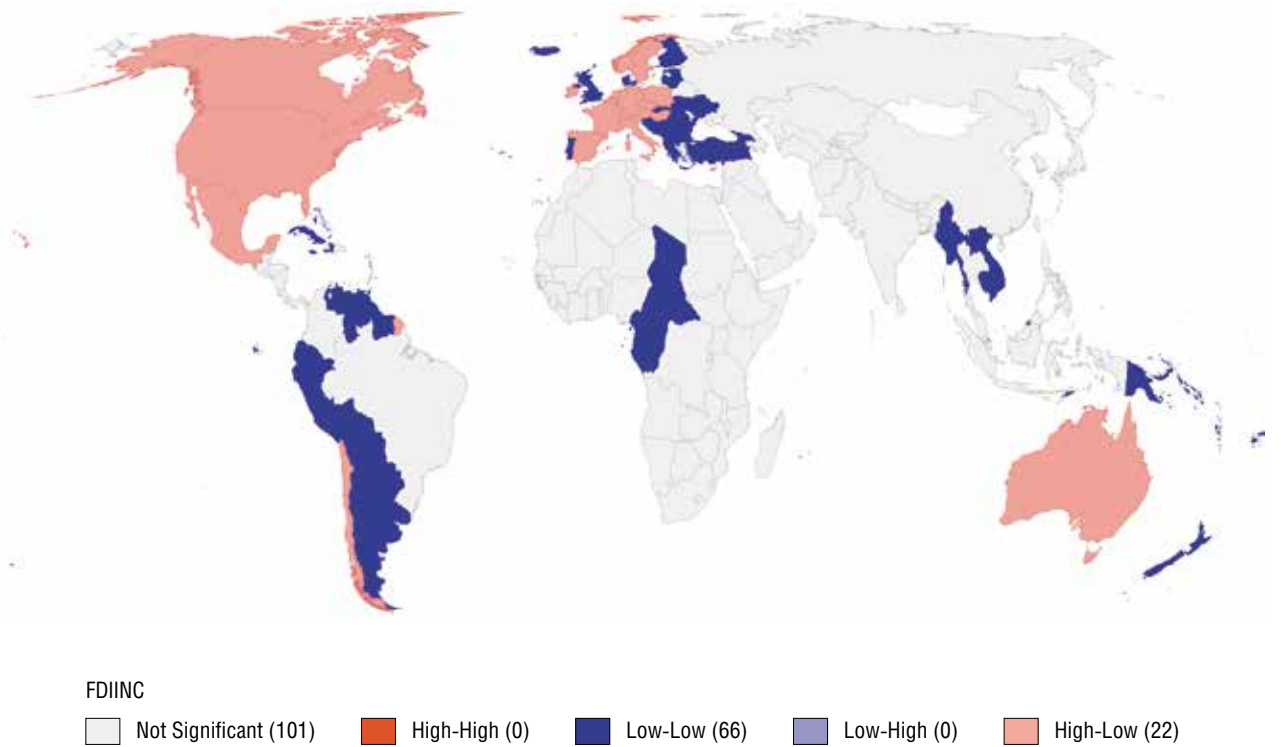


Fig. 4.9.4. “FDI inflows” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.10. Royalties to foreign copyright holders

This indicator measures the amount of cross-border payments for the temporary use within a given state of intellectual property registered at any time up to and including 2018, primarily patents and foreign invention licenses.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.236	0.000	0.077	0.001
Geary's C	0.812	0.060	0.919	0.001

This indicator demonstrates highly uneven worldwide distribution: indicator values that are hundreds of times greater than the median are observed in dozens of countries. The arithmetic mean is 31 times greater than the median. The range of values indicates significant variation of this parameter. The leaders in royalty payments are Ireland and the Netherlands, both active users of technologies developed in the United States. These countries have attracted many “subsidiary” tech firms of American TNCs in recent years. Conversely, 50 countries demonstrate indicator values that are close to the minimum.

The percentile cartogram (Fig. 4.10.1) shows that most states with high indicator values are located in Eurasia. This may be explained by the diffusion of innovations over land, or by the fact that the Northern Hemisphere has hi-tech companies that need foreign designs more so than companies in the South.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The Western European cluster on the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 4.10.3) includes the United Kingdom, Ireland, France, Belgium, the Netherlands, Germany and Switzerland. Many companies from these countries actively use technologies from all over the world since they strive to preserve their key standings in the global added value chains. Royalties paid to foreign copyright holders are also high because these developed economies have large companies capable of paying for expensive designs.

Global place	Country	Indicator (USD million)
1	Ireland	85,482
2	Netherlands	45,141
3	US	43,932
Mean (24)	(Argentina)	2,788.8742 (2030)
Median (76)	Latvia	65
124–127	4 countries	2
128–133	6 countries	1
134–151	18 countries	0

West Africa is dominated by countries that cannot afford — or do not want — to use foreign technologies: here we have a cluster comprising Algeria, Niger, Nigeria, Tanzania, Zambia, Togo, Benin, Burkina Faso and Senegal. Due to their poverty, the populations of these countries rarely demonstrate demand for products with high added value (including science-intensive products). In turn, local manufacturers, unsure of the cost-effectiveness of innovations, do not feel the need to rent or purchase technologies abroad. Additionally, some developers are wary of cooperating with African companies. The same situation applies to Fiji and its neighbours.

The countries surrounding Mongolia pay foreign copyright holders far greater amounts than Mongolia does itself, which suggests that its predominantly agrarian economy also affects the pace of adapting foreign designs. Myanmar is in a similar situation, also contrasting with its neighbours, although the country's situation is exacerbated by political instability, which means that only security technologies and the like are in demand, rather than civil industrial ones.

International disproportions in Europe and the differences between most states in Southeast and Northeast Asia emphasized in the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 4.10.4) may stem from the uneven involvement of national economies in the global economy. In particular, high indicator values are typical for territories where businesses that are actively involved in global added value chains and related technology transfer operate: for instance, countries with many “assembly plants” (such as Poland) or companies capable of paying for foreign designs used to improve local products. Conversely, African integration alliances appear monolithic from this point of view.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Royalties to foreign copyright holders” parameter (Fig. 4.10.2) yielded identical results in Latin America, around Indochina, and in Southeast Africa. Technological exchange in these countries is not particularly intensive, and organizations pay approximately equal amounts for using intellectual property.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Number of doctors	0.039	0.015	0.259	1.701
2	Availability of electricity	0.057	0.003	0.290	1.471
3	Railway network	0.077	0.003	0.280	1.012
4	Urbanization	0.053	0.005	0.218	0.902
5	Particulate air pollution	0.033	0.037	-0.171	0.885
6	Access to electricity	0.026	0.046	0.15	0.851
7	Bank deposits	0.047	0.010	0.198	0.842
8	Secondary education enrolment	0.067	0.002	0.230	0.790
9	Conflictogenity	0.038	0.027	-0.169	0.751
10	Maternal mortality	0.033	0.028	-0.151	0.699

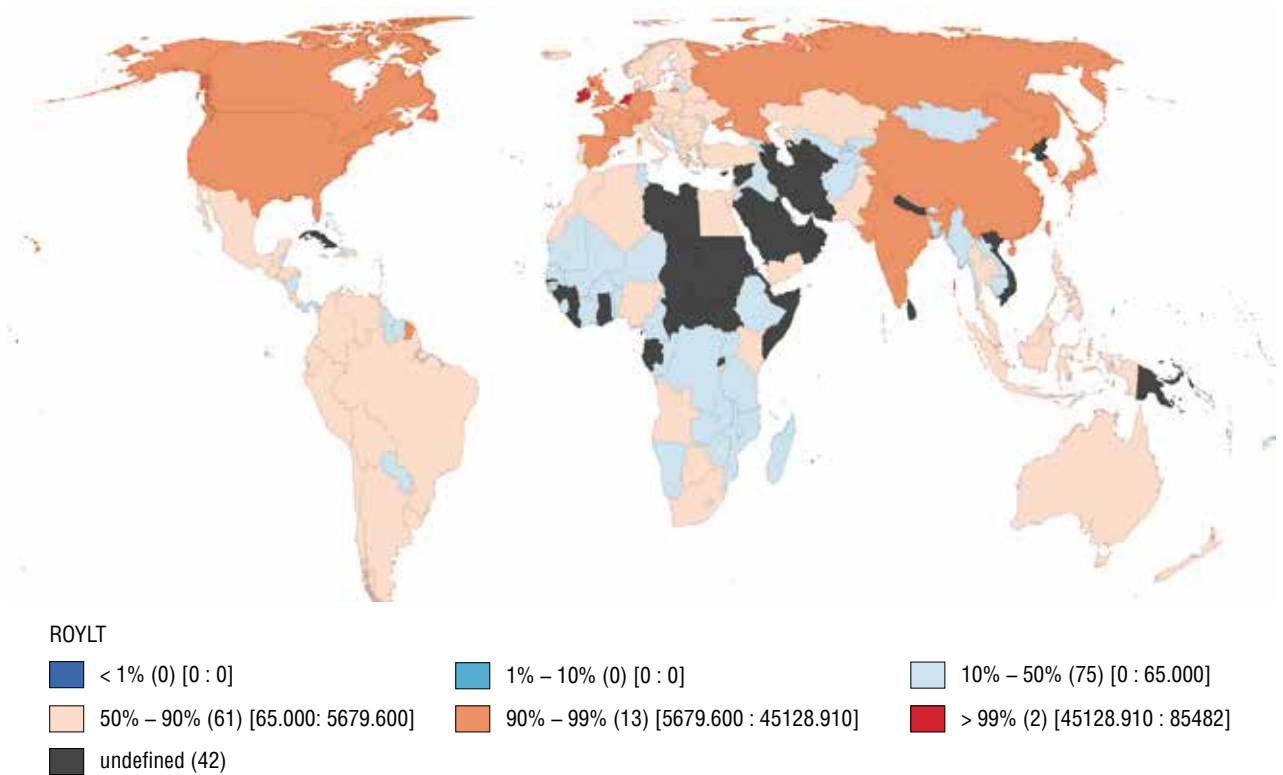


Fig. 4.10.1. Percentile cartogram for the “Royalties to foreign copyright holders” indicator

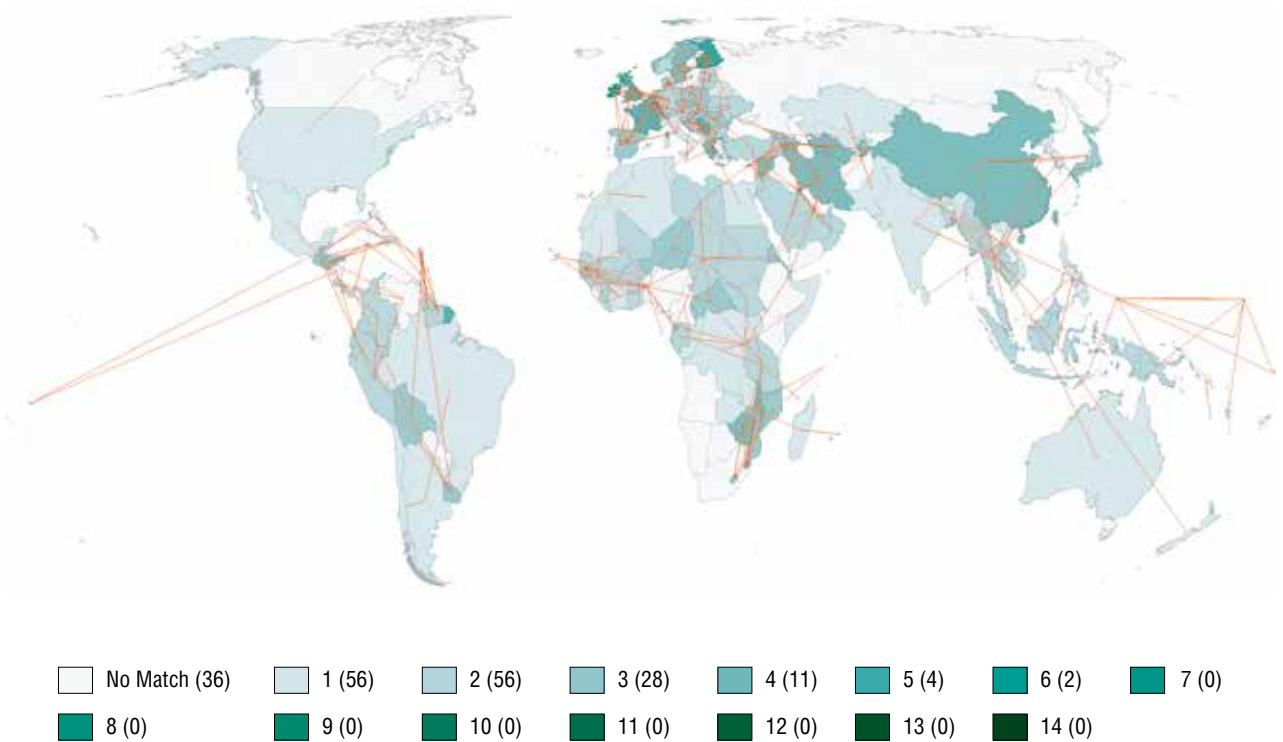


Fig. 4.10.2. Likelihood-ratio test for the “Royalties to foreign copyright holders” parameter

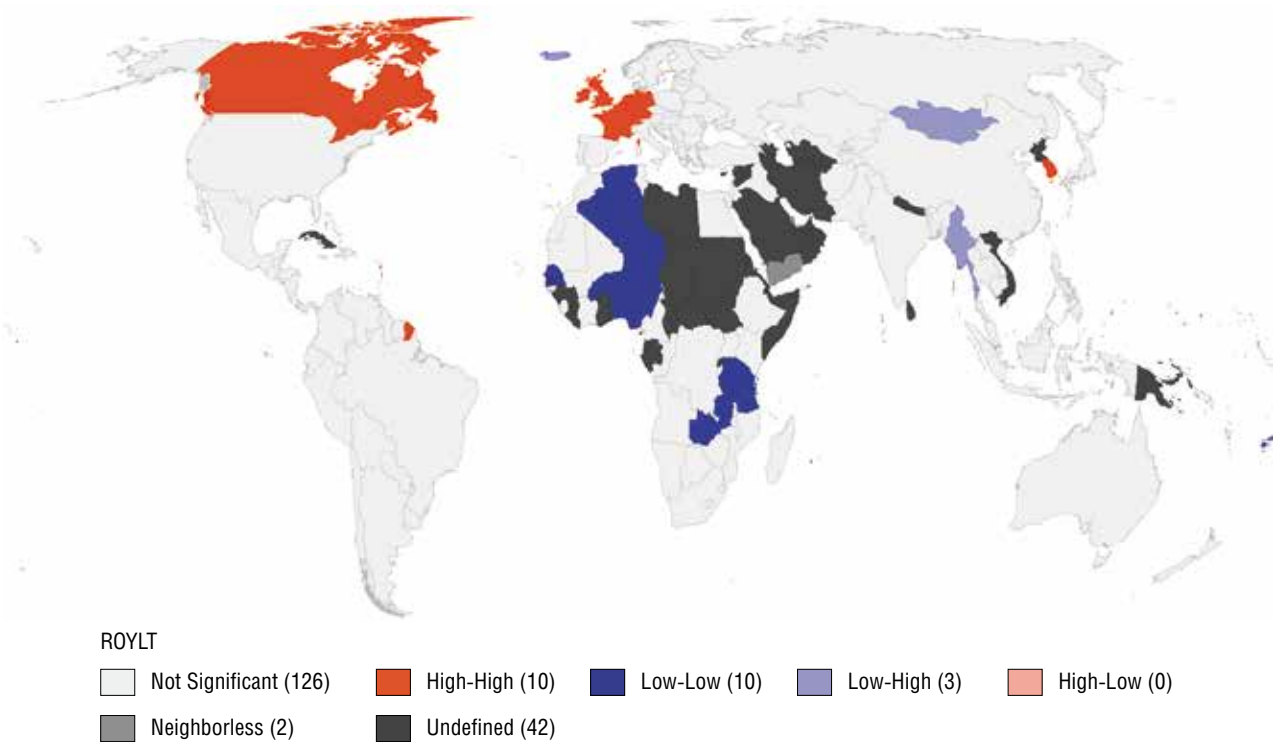


Fig. 4.10.3. “Royalties to foreign copyright holders” spatial autocorrelation cartogram for the geometric neighbourhood matrix

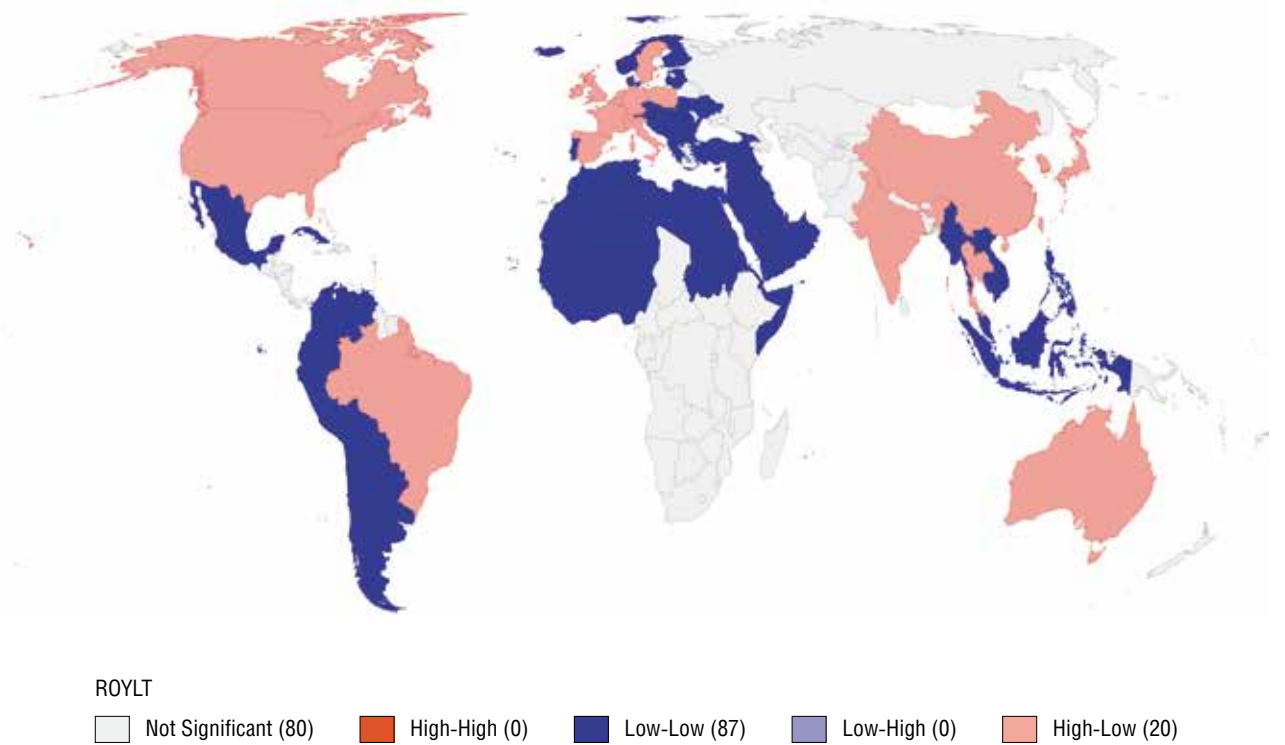


Fig. 4.10.4. “Royalties to foreign copyright holders” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

4.11. Multifactor analysis of the “Finance” section indicators

The research team discovered a difference in global geographic averages in FDI income, foreign assets of banks, and bank deposits. Out of these three indicators, deposits are the most evenly distributed since many employees with high wages and wealthy depositors are not exclusive to the Northern Hemisphere and can also be found in Australia, South Africa, Brazil and Chile. Additionally, populations in developed northern states have access to non-traditional savings instruments that compete with deposits and drain spare money from bank deposits.

Both remaining global indicator averages are skewed toward the countries of North America and Western Europe: their active involvement in international capital movement manifests itself in the amounts of dividends paid on inward FDI stock and loans to foreign enterprises. Despite their location in the hotbed of the 2008–2010 financial crisis, the relative economic stability achieved just ten years later allowed their businesses to profit from foreign investment and issue loans to foreign businesses on their own. The geographic average of foreign assets of banks is less skewed to the north than investment income since it takes the resources of Australian banks into account. A more stretched ellipse of investors income stems from countries in Asia that have many foreign enterprises, but few foreign banks: Kazakhstan, China and Russia.

The next chart records diverging geographic averages under the geopolitical neighbourhood matrix. Considered individually, geopolitical blocs demonstrate varying volumes of FDI income and domestic loans to legal entities. The first indicator is skewed towards highly profitable Russian and Nigerian oil rigs that are partially owned by foreigners, as well as countries with many foreign enterprises that demonstrate medium profitability: China, the United States and Mexico. Amounts of domestic loans in these states are insufficient to stretch the average lending ellipses to match, since many American and Mexican companies finance their projects through the capital market instead of via banks, and loans to many Chinese public companies may not show up in the statistics. Additionally, Japan and ASEAN have many solvent companies that can afford to pay interest rates on loans, thereby supporting high lending levels and balancing out the portfolios of Chinese banks.

Value cartograms for multifactor Geary's C are typical for those groups of countries that are most similar or most dissimilar to their neighbours in these parameters.

Calculations under the geometric neighbourhood matrix (Fig. 4.11.1) show most Eastern European states grouped with Italy, while many countries of Tropical Africa (not only with missing values) are also combined into a separate cluster. The states within these groups have similar values of indicators that point to a shortage of domestic resources (primarily in the banking systems, including Italian banks that were affected the debt crisis, and these values attest to small volumes of deposits and loans to legal entities). Neighbours on the Scandinavian Peninsula, on the contrary, stand out in their strong financial institutions.

An analysis of financial indicators using a geometric neighbourhood matrix (Fig. 4.11.2) showed homogeneity of Central American and East and West African international organizations, including members with similar economic structure. In the states from the group of post-Soviet countries that was selected, resource rent and spare funds among economic agents are relatively rarely involved in economic exchange via bank deposits and state budget spending (the budget in Azerbaijan demonstrates one of the world's highest surpluses).

Most Euro-Atlantic countries differ from the United States and the Netherlands — the two leading countries on the global capital markets. The financial indicators of Pakistan, Bangladesh and Sri Lanka are also similar, while India, which is wedged between them, stands out in most parameters.

A cluster analysis without taking geographic proximity factor into account (Fig. 4.11.3) revealed differences between groups of European countries with similar medians for the ten financial indicators. Belgium and France are also part of the group of countries that suffered from the debt crisis along with Italy, Greece and Portugal. Eastern European countries also are not connected with financially stable Germany, Switzerland and Scandinavia.

It is noteworthy that even without taking into account geographic proximity the Post Soviet states formed a separate cluster joined by other former states of the Socialist camp, including such different countries as Mongolia and Poland. In the Middle East, there is a similarity between states that regularly receive funds from the export of hydrocarbons: Iran and the smaller countries of the Persian Gulf.

The second cartogram (where equal weights are assigned to the geographic neighbourhood and statistics indicators — Fig. 4.11.4) adds North African countries to this Middle Eastern cluster, in consistency with the concept of the Greater Middle East with several Central Asian countries. It is noteworthy that Yemen joined the African cluster and Oman is part of the Indian cluster.

Each country in Southeast Asia is located in its category in the first chart, but the second chart adjusted for neighbourhood combined all countries in the region, with the exception of Indonesia, into a single cluster. Even though most ASEAN member states are part of this cluster, this variety (differences in statistical indicators in the first chart; Indonesia's absence) may explain political contradictions over integration in this format. The same cluster is joined by India.

North and South Korea differ both from each other and from other regional countries that they are both included into different clusters of non-neighbours. North Korea joined the Middle East, whereas South Korea became part of the South and South-East Asia, with which it actively deepens cooperation. With the geographical proximity accounted for, Turkey and Israel (that are too different from their Arab neighbours also in terms of the financial systems) joined the cluster of the former Socialist camp, whereas Serbia stands out clustering with the Middle Eastern states.

The cartogram once again reveals the cleavage between Western and Eastern Europe, with Western European states joined by Canada. Ireland and the Netherlands stand out from the Western European cluster, which can indicate the peculiarities of investment flows going through these countries. All in all that is the European continent that is the most diverse by the financial parameters. World leaders - China and the USA - stand aside, proving the specificity of their financial systems.

The scatter plot based on the results of multidimensional scaling (Fig. 4.11.5) shows differences between most countries of the world and those that have large spare funds. These funds ensure a stable economy and the opportunity to take an active part in global financial flows for the United States, the Netherlands, China, Japan, Luxembourg, Ireland and Switzerland. The situation of the Bahamas demonstrates that financial internationalization alone is not sufficient to break away from the principal group of states. East Timor is different from them primarily in its treasury's revenues. Russia is also different in terms of the amount of sovereign debt and volume of deposits.

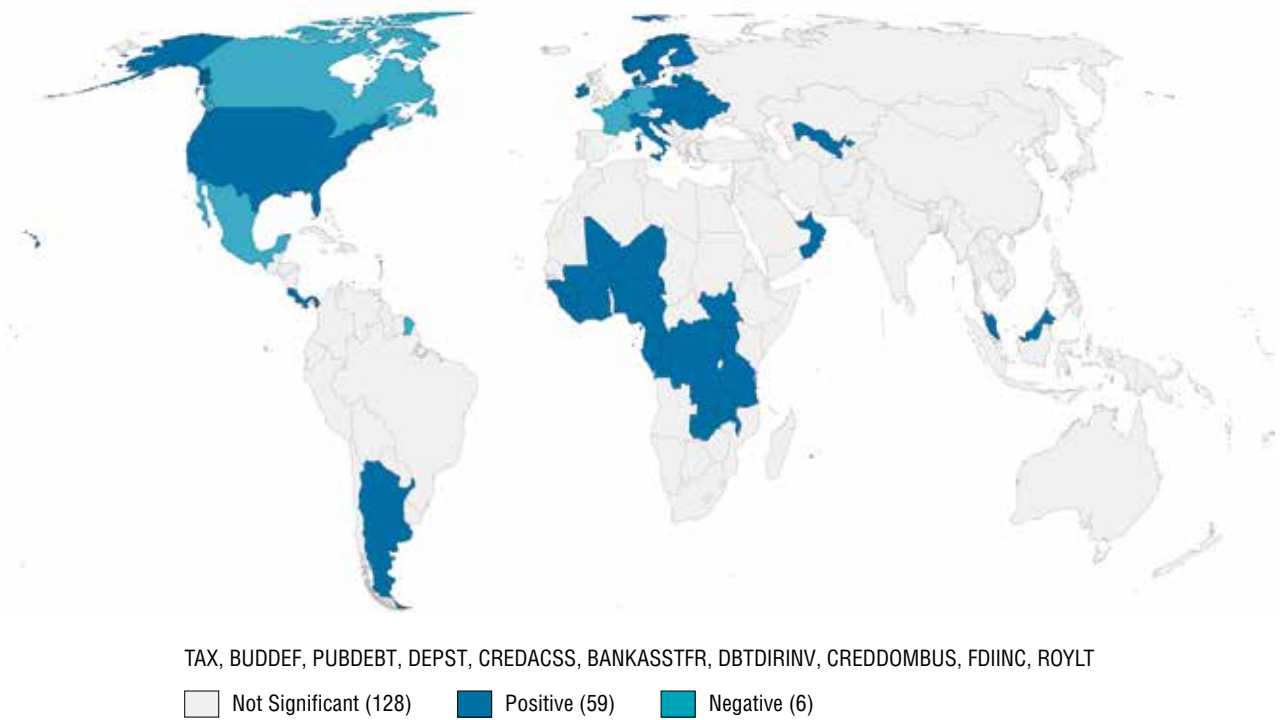


Fig. 4.11.1. "Finances" section spatial autocorrelation cartogram for the geometric neighbourhood matrix

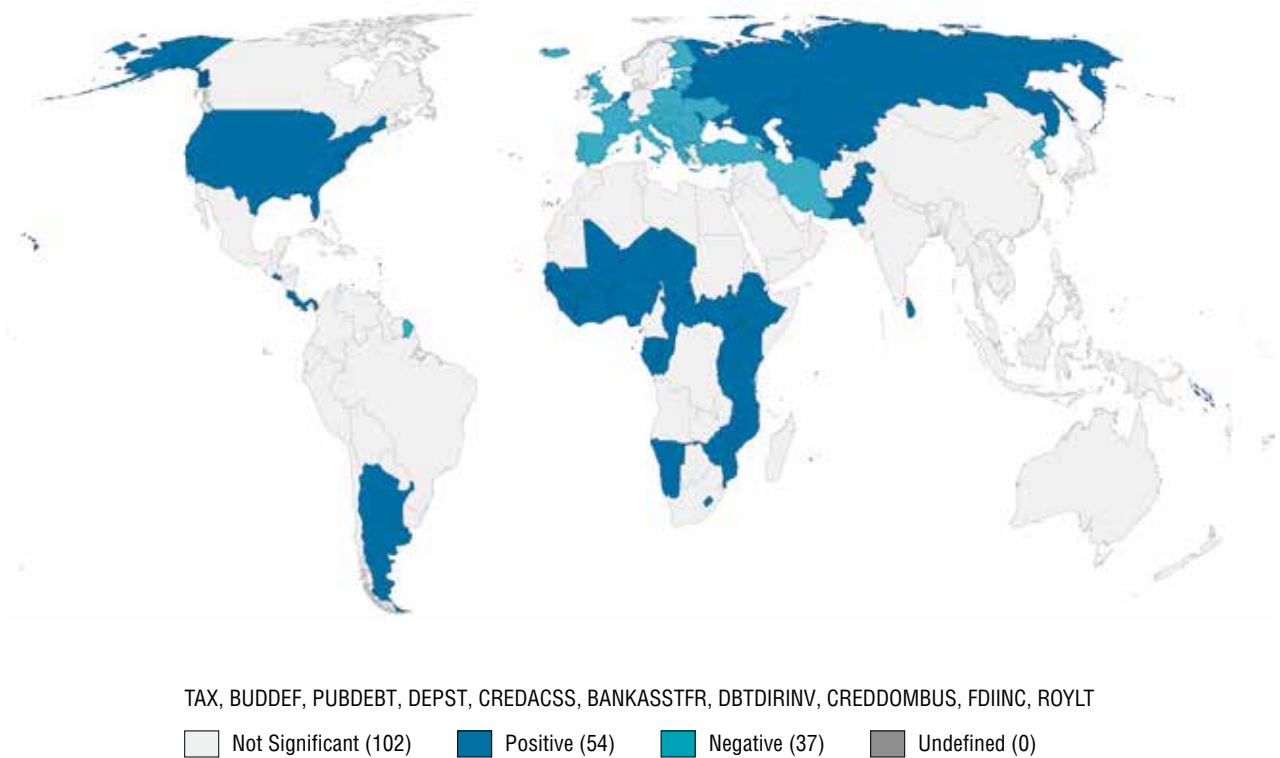


Fig. 4.11.2. "Finances" spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

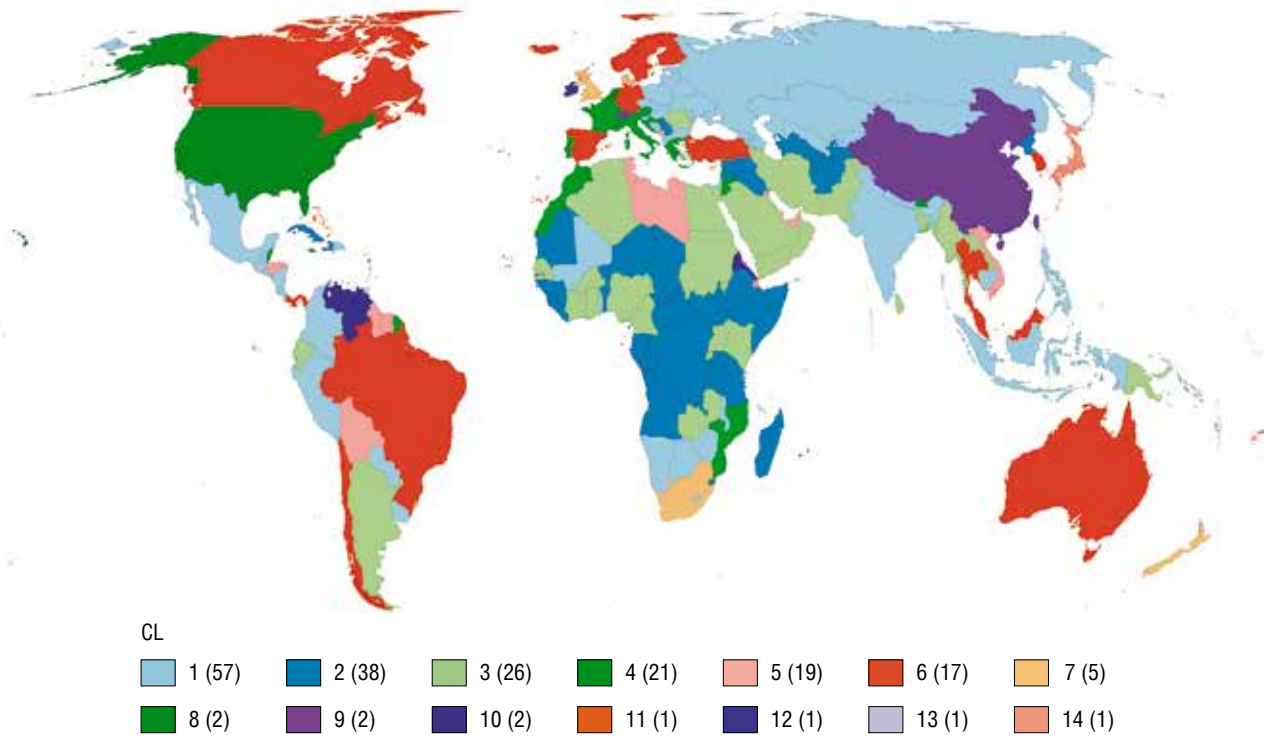


Fig. 4.11.3. Statistical clusters cartogram for the “Finance” section indicators

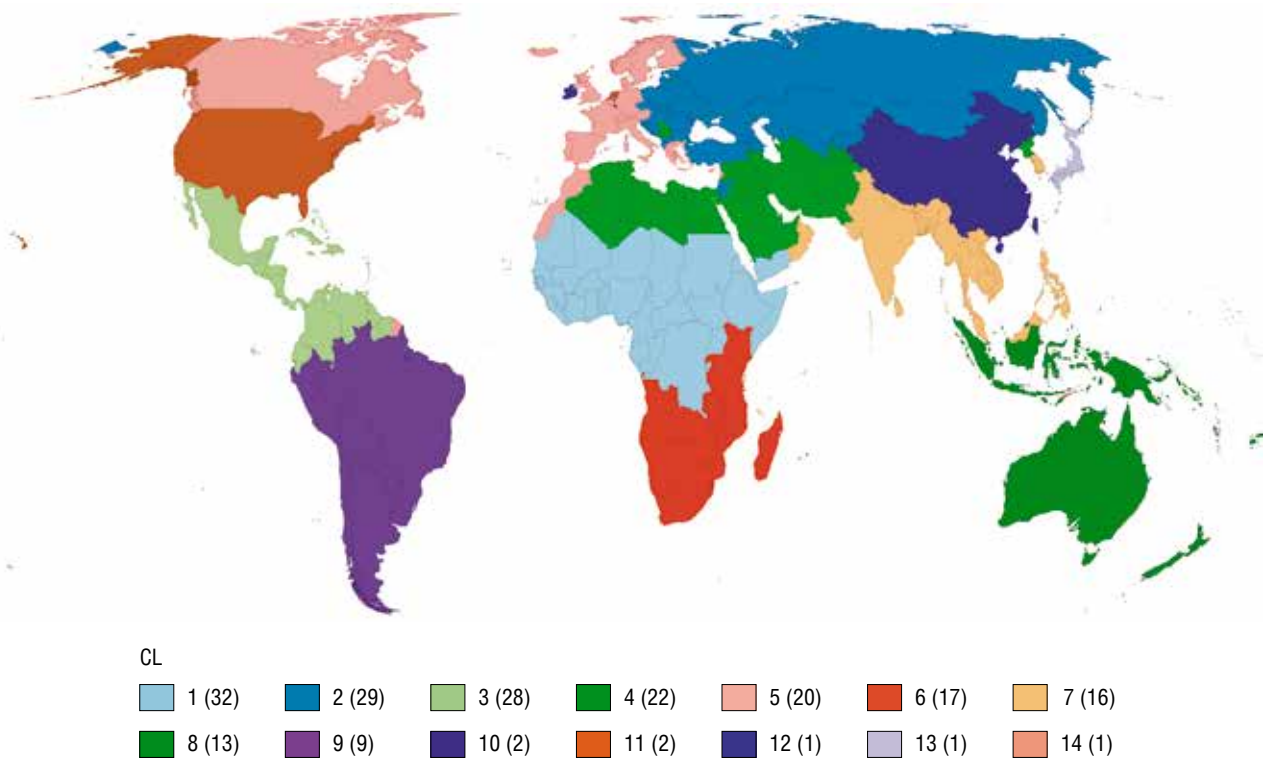


Fig. 4.11.4. Statistical clusters cartogram for the “Finance” section indicators adjusted for geographic proximity

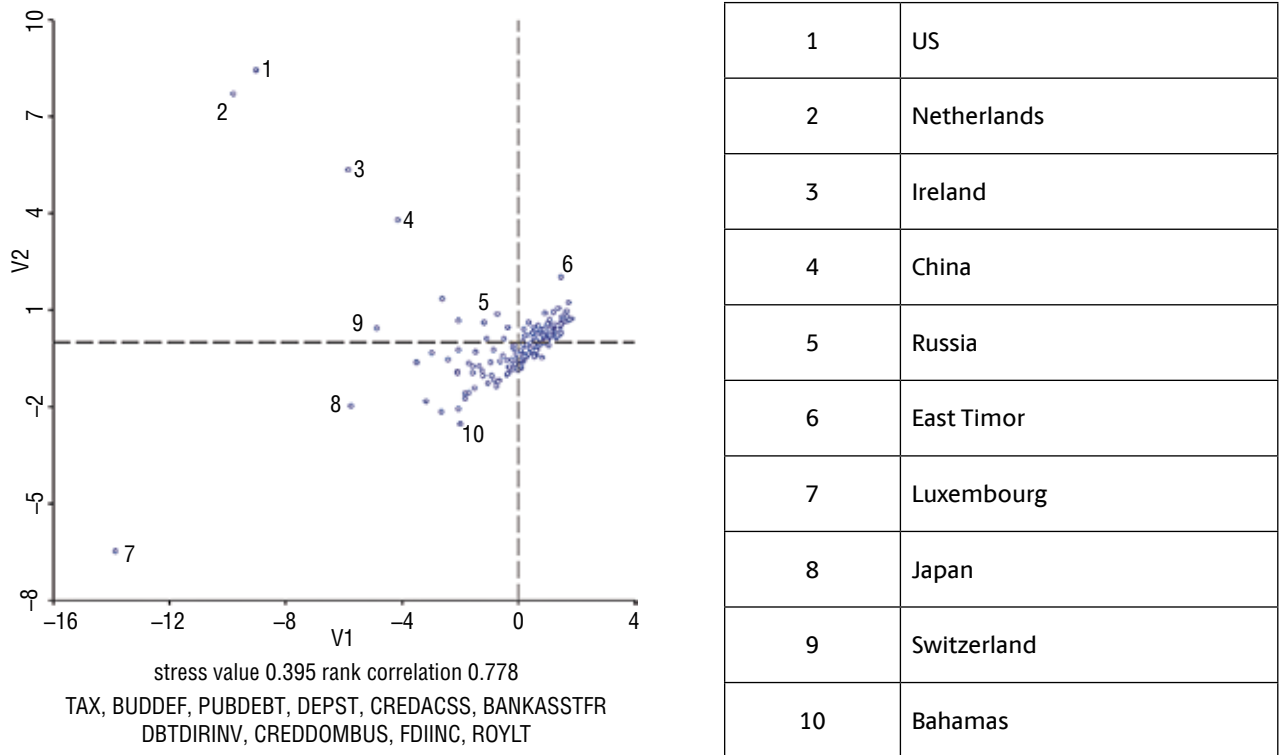


Fig. 4.11.5. Multidimensional scaling chart for the "Finance" section indicators

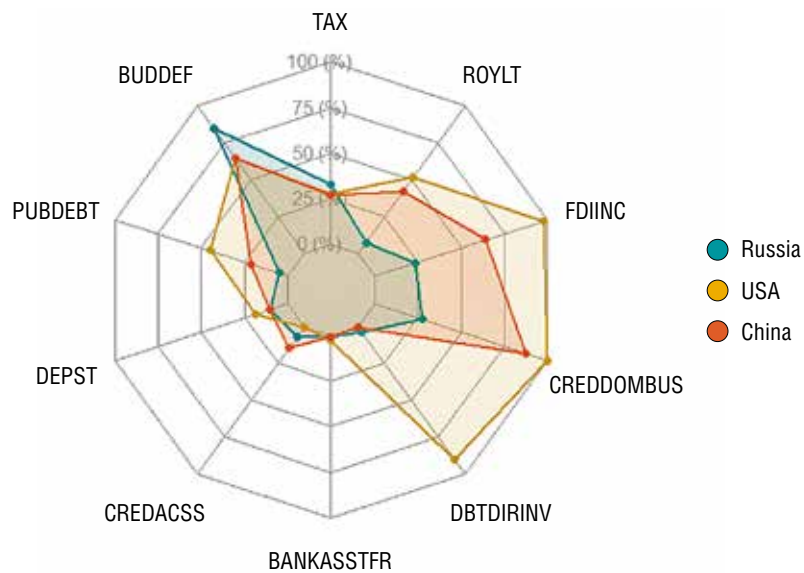


Fig. 4.11.6. Radar chart for the "Finance" section indicators

4.12. Spatial factor and “Finance” section indicators

Financial indicator analysis identified various parameters of their spatial distribution. First of all, we need to state that countries do not have equal financial resources: the highest values for many indicators analysed are recorded in developed countries (mostly in Western Europe and North America). Previous subsections showed that dozens of countries that are significantly ahead of other states in terms of volume of deposits (Fig. 4.4.1), lending to domestic companies (Fig. 4.6.1), or participation in international capital flows (Fig. 4.7.1, Fig. 4.8.1, Fig. 4.9.1) are clustered in the Euro-Atlantic region. These countries are superior not only to most states of Africa, Asia and South America, but also to their Eastern European partners in NATO and the European Union. Judging by a comparison of all countries between Canada and Finland (see Fig. 4.4.3, Fig. 4.5.3, Fig. 4.6.3 and Fig. 4.8.3), the difference between European countries is most starkly manifested in the results obtained by calculations using the geopolitical neighbourhood matrix and not the geometric neighbourhood matrix.

Western European and North American countries may differ significantly from other financially prosperous states (for instance, the resource-rich monarchies of the Persian Gulf) since the accumulated wealth of these developed countries increases due to two distinguishing institutional features. Their reputations as reliable borrowers allowed their governments to borrow funds in excess of half of their GDP. Additionally, local banks were, over the course of several centuries, able to not only increase their capital via the credit multiplier, but also transform loans into profitable property. Their offer of borrowed resources on the domestic (Fig. 4.6.1) and global markets (Fig. 4.7.1) is large thanks, in particular, to the region's soft monetary policy.

As for banks in developing countries, their activities on domestic and foreign capital markets are largely determined by consumer demand. Spatial aspects in many identified interconnections may be explained by creditors taking the prosperity of foreign consumers in foreign (particularly neighbouring) countries into account: the solvency of potential foreign clients of those enterprises that apply for loans (including foreign loans). Pursuant to the findings of such assessments, banks frequently grant the opportunity to manufacture goods on credit to companies from those territories where manufacturers may take advantage of their country's proximity to the capacious market of a neighbouring state, or its initial presence on that market.

Indeed, calculations of the two-factor Moran's I (values are given in tables concluding the sub-sections for each indicator) identify such connections between financial indicators and variables from other sections of this book. Banks are more inclined to issue loans to domestic enterprises (Fig. 4.6.1) when their surroundings are more favourable for export: lenders may consider borrowers to be more promising if they neighbour states with high levels of import, urbanization and GDP per capita (consequently, with solvent demand for a broad range of products that do not enjoy popularity in rural areas) and where goods can be delivered quickly (via a developed network of railways and motorways and without encountering prohibitive customs barriers thanks to importers being members of various free trade zones [FTZ]).

Financial institutions may consider a foreign borrower in the same situation acceptable. This is likely the reason why foreign assets (Fig. 4.7.1) are owned by banks in countries whose neighbours have the prerequisites for exports. Supposing that financiers tend to issue loans not to enterprises in faraway countries, but to members of more familiar neighbouring markets, the logic described would explain the following observation: banks in country A may have a significant portfolio of loans issued to foreign businesses (located, for instance, mostly in the neighbouring state B and not across an ocean), if these companies may export goods from B to C without major obstacles (as in the above-mentioned domestic lending scenario, via railways and motorways, without customs barriers within an FTZ).

Additionally, banks are more likely to lend to foreign enterprises if the neighbouring country B has a stable local demand for the borrowers' products (proceeding from the assumption that borrowers are also primarily located in country B): this may be evidenced by GDP per capita, life expectancy, high education level and low taxation rates (as these rates reduce purchasing power). Lenders may also be attracted by the

infrastructural conditions of a borrower's solvency, where, for example, state B has extensive access to electricity, the internet, and railways.

Thanks to location next to stable markets, the deposits to GDP ratio (Fig. 4.4.1) is frequently also high, as evidenced by the two-factor analysis: international trade earns spare funds for the national economy in general, and for individual employees of exported goods manufacturers. These circumstances may explain the size of bank deposits in the proximity of countries that import large quantities of goods, are members of numerous FTZs, have an appropriate sales infrastructure (access to electricity), and a prosperous population (high GDP per capita and life expectancy).

Unlike depositing commercial revenues in a bank, earning profits in the course of a longer international partnership (by receiving dividends on foreign direct investment — Fig. 4.9.1) entails removing a certain share of revenues from the national economy. This is why countries whose location is conducive to their involvement in international trade are drained of large volumes of revenues received with foreign participation. Namely, the vicinities of countries with large foreign trade quotas and a ramified network of partners in many FTZs demonstrate high FDI income. It is likely that intensive trade ties encourage the creation of joint ventures that share part of the profits earned from trading or processing as part of global production chains with their foreign co-founders.

The same patterns are observed on the European continent (where relatively solvent customers are present both on a given bank's domestic market and on the neighbouring domestic market), and consequently, there are global correlations (recorded as high values of two-factor Moran's I) between non-financial independent variables and certain financial indicators. Other indicators mostly did not correlate with financial characteristics of neighbouring countries outside Europe and North America.

Findings obtained by the single-factor analysis of financial indicators (not adjusted for connections with variables from other sections of the book) are similar in that they do not give solid grounds to confirm the principal hypothesis. The spatial autocorrelation under the geometric neighbourhood matrix was frequently higher than the analogous parameter of connection under the geopolitical matrix (for some indicators, Moran's I for different matrices differed threefold). Telling in this respect is the first table in the sub-section on loans to domestic companies: the coefficient for the geopolitical matrix is large (0.220), but it is still 1.5 times smaller than the results obtained by calculations under the geometric matrix (0.335).

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5 *Politics*

Democracy Institutional Framework

Voter turnout

Women in politics

Public organizations

Corruption

IMF voting power

Diplomatic missions

Passport power

Conflictogenity

Military expenditure

*Multifactor analysis of the “Politics”
section indicators*

*Spatial factor and “Politics”
section indicators*

THE “Politics” section covers ten indicators grouped into two large categories. The first describes a given state’s domestic politics, while the second focuses on its international influence. This grouping is based on the premise that a citizen’s living conditions in a state, their wellbeing and the full realization of their potential depend on the global position of their native country and its political system and culture, as well as on its neighbours and their characteristics. Nevertheless, let us note that today, domestic political matters are frequently resolved by several international relations actors applying their efforts internationally.

The first indicator in the section is democracy institutional framework. Voter turnout is the next indicator of domestic system development since it measures the legitimacy of the current system: the higher the index, the higher the legitimacy [Teixeira 1992]. Voter turnout is the most widespread instrument of citizens’ involvement in political process since voter turnout reflects people’s satisfaction with their state’s policies, their government’s decisions, and it also shows the distribution of votes between political parties [Young 2005]. Female representation in national parliaments also reflects how democratic a system is. Studies note that states where democratic institutions have a longer history boast more women in their national parliaments [Tremblay 2007]. Non-profits are important for understanding political processes in a state since non-profits may be involved in political decision-making and form the core of civil society. Finally, the fifth indicator in the domestic politics section is the corruption perceptions index. L. Pellegrini and R. Gerlagh (2008) noted that when a democratic regime has been maintained for a long time, the level of corruption drops, while political instability results in greater corruption. Consequently, the research team believes that the corruption perceptions index is important for understanding people’s quality of life in a given state, and, therefore, this index was included in our analysis.

As for foreign policy indicators, the first one is the IMF voting power. The indicator is significant since rich countries paying greater quotas have greater influence on the Fund’s decision-making process, while developing states note a “democracy deficit” and a small window of opportunity for influencing the IMF’s policies and programmes [Bloomberg & Broz 2006]. As for the number of diplomatic missions, this indicator shows how well a state is integrated into the international system and the number of states with which it has established diplomatic relations. Let us move on to the passport power indicator, which shows the degree to which a state’s friendly relations ensure its citizens’ mobility. Passport power and the ease of obtaining visas also attest to how well a given state’s “soft power” works [Shapiro 2016]. Conflicts

are also an integral part of the international life of countries, as states may be involved both directly and indirectly in such events. This, in turn, may serve as an indicator of a state's international influence and the opinion its citizens have about their country's action in this area. Moreover, conflicts affect the investment climate, for instance, in developing states [Kim 2016]. Finally, a state's international power may be assessed via its military spending. Given the neorealist take on international relations [Waltz 1988], an external threat may be seen as the force that makes states spend large amounts on their militaries [Nordhaus & Oneal, 2012] to protect their interests. Consequently, this indicator needs to be taken into account when assessing its influence on the quality of life of the people in a given state. Moreover, let us note that there is a correlation between military spending and economic growth; namely, there is a connection between high military spending and economic growth, which also has a positive effect on the overall quality of life.

5.1. Democracy Institutional Framework

Democracy institutional framework was operationalized via democracy index, more specifically through global freedom index. The indicator is important because the degree of human and civil rights indicates the type of political regime in a state, which, in turn, influences people's quality of life.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.575	0.000	0.525	0.000
Geary's C	0.441	0.000	0.473	0.000

The percentile cartogram (Fig. 5.1.1) shows that the highest democracy levels are observed in Canada, Uruguay, Australia, Japan, Northern Ireland, Portugal, Switzerland, Belgium, the Netherlands, and in the Scandinavian countries. The lowest figures are seen in two states, South Sudan and Syria, due to civil wars in both countries and the impossibility of establishing a stable democratic rule.

Generally, the world is notionally divided into western states, which traditionally appear more democratic, and eastern states that are (with rare exceptions) autocracies. All states in Latin America, with the exception of Venezuela, are presented as democratic. As for Venezuela, we need to take the 2019 political crisis into account, which came after early presidential elections on May 20, 2018 won by the incumbent president Nicholas Maduro, whose victory prompted protests both within the state and in most states of the West and Latin America.

The geometric neighbourhood matrix yields a slightly greater spatial correlation than the geopolitical matrix, and, consequently, the hypothesis that the world's geopolitical structure has greater significance is not confirmed. At the same time, both values are nearly identical, which means that both geometric and geopolitical situations are important for this indicator.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.1.3) shows two large clusters. The first, which shows for both the state in question and its neighbours includes the countries of Western and Northern Europe, the old democracies. This cluster emerged, first, due to long-standing democratic traditions in the states that make up this cluster, and, second, due to requirements established for EU member states. The second cluster includes states of Northeast and Central Africa, the Middle East, Central Asia, and China. These countries are traditionally seen as more authoritarian, "oriental" despotic states that, in the opinion of western countries, cannot be classified as democratic. Despite its neighbors, India wasn't included in the cluster which should have been autocracy but proves its status of

Global place	Country	Indicator
1	Norway, Sweden, Finland	100.00
2	Netherlands	99.00
3	Canada, Luxembourg, Uruguay	98.00
Median (95–97)	Bolivia, Lesotho, Macedonia	63.00
Mean (109)	(Philippines)	58.84 (59.00)
190–191	Turkmenistan, Eritrea	2.00
192	Syria	0.00
193	South Sudan	-2.00

“the world’s largest democracy.” Mongolia is an exception, too: despite its authoritarian neighbours, it is a democracy according to the Democracy Index.

The geopolitical neighbourhood matrix cartogram (Fig. 5.1.4) shows two large clusters. The first includes Western states (with the exception of Bosnia and Herzegovina) that are representatives of the “democratic” world. The second large cluster includes the states the western world believes to be autocracies: the countries of North, Central and East Africa, the Middle East, Central Asia, and Russia. Another clear standout is Turkey, which is part of an “error” cluster — that is, it should have been part of the “European bloc,” yet represents autocratic political systems. Other exceptions are Japan, which should be a non-democratic country under the neighbourhood matrix, but belongs to the Western democratic world, as does Kiribati.

A comparison between the cartograms for geometric and geopolitical neighbourhood matrices reveals the following differences. First, the geopolitical neighbourhood matrix has subsumed virtually all western states, including the United States and Canada, under the democratic state cluster. Therefore, the world is notionally divided into two camps, which was not the case in the geometric neighbourhood matrix. Second, the geopolitical neighbourhood matrix has “lost” China, which, unlike the geometric matrix, became part of an “insignificant values” cluster or a “neutral cluster.” This can be explained by the regime as such not playing an important role for China when considered among its geopolitical neighbours, as can be gleaned from both its foreign political activities and its relations with other countries. Third, Russia is part of the autocratic cluster on the geopolitical matrix cartogram and is no longer an exception to the rule, which was the case on the geometric neighbourhood matrix cartogram. This may attest to the fact that, geopolitically, Russia cannot be classified as part of the democratic world, while geometrically, it should have been influenced by the proximity of European states and should have potentially been in the democratic camp, but currently, it is an “outlier.”

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Institutional foundations of democracy” parameter (Fig. 5.1.2) reveals connection nodes between European states. These connections may be seen as the basis of European integration, because states with similar values for level of democracy are grouped in a single cluster. Additionally, connection nodes can be observed for the countries of the Caribbean. Virtually all states in the node are members of the Caribbean Community. In Africa, ECOWAS states exhibit similarities. The Middle Eastern states are also similar and also demonstrate connection nodes. Finally, we can observe connections between ASEAN member states that also show similar Democracy Index values.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Linguistic diversity	0.0815	0.000	-0.348	1.486
2	Cultural solidarity	0.040	0.016	0.225	1.276
3	Ethnic fractionalization	0.029	0.033	-0.186	1.177
4	IMF voting power	0.021	0.049	0.149	1.079
5	Population growth	0.146	0.000	-0.387	1.025
6	Women in politics	0.023	0.033	0.154	1.010
7	Number of doctors	0.145	0.000	0.344	0.817
8	Highly wealthy population	0.044	0.009	-0.181	0.746
9	Tuberculosis morbidity	0.070	0.000	-0.227	0.731
10	Female population	0.072	0.000	0.224	0.697

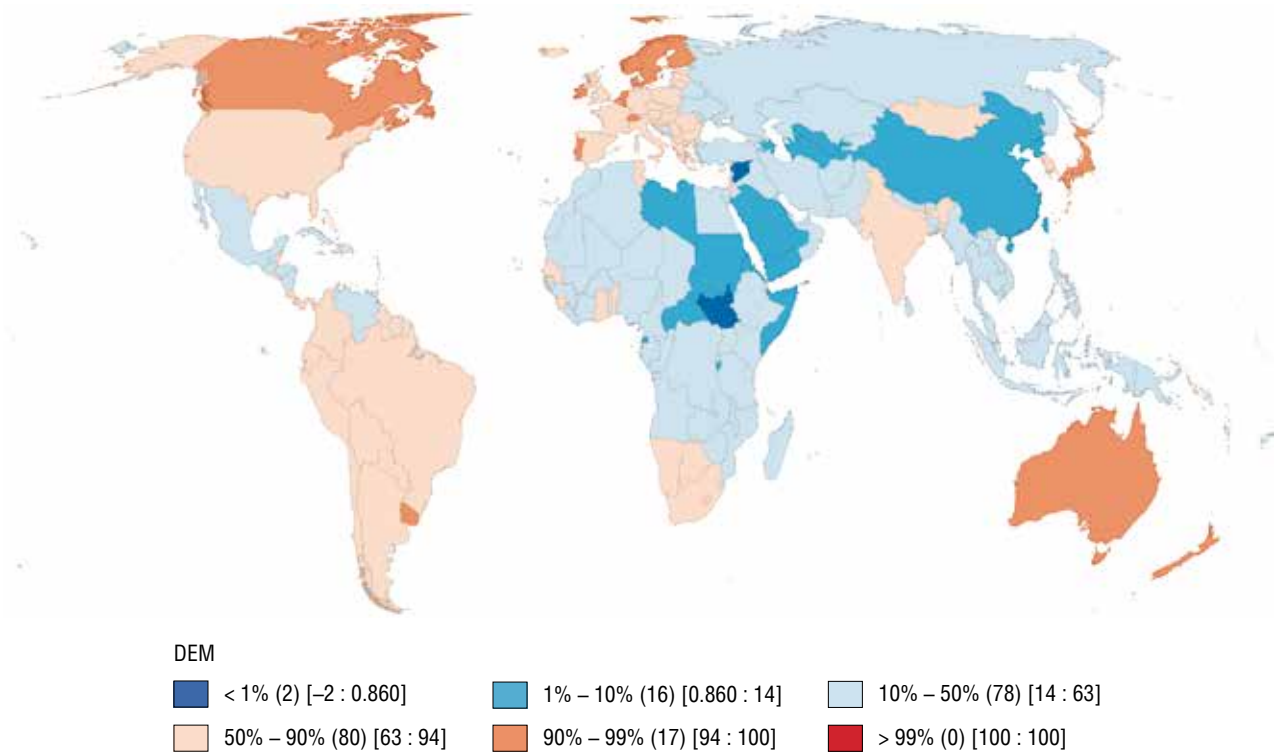


Fig. 5.1.1. Percentile cartogram for the “Institutional foundations of democracy” indicator

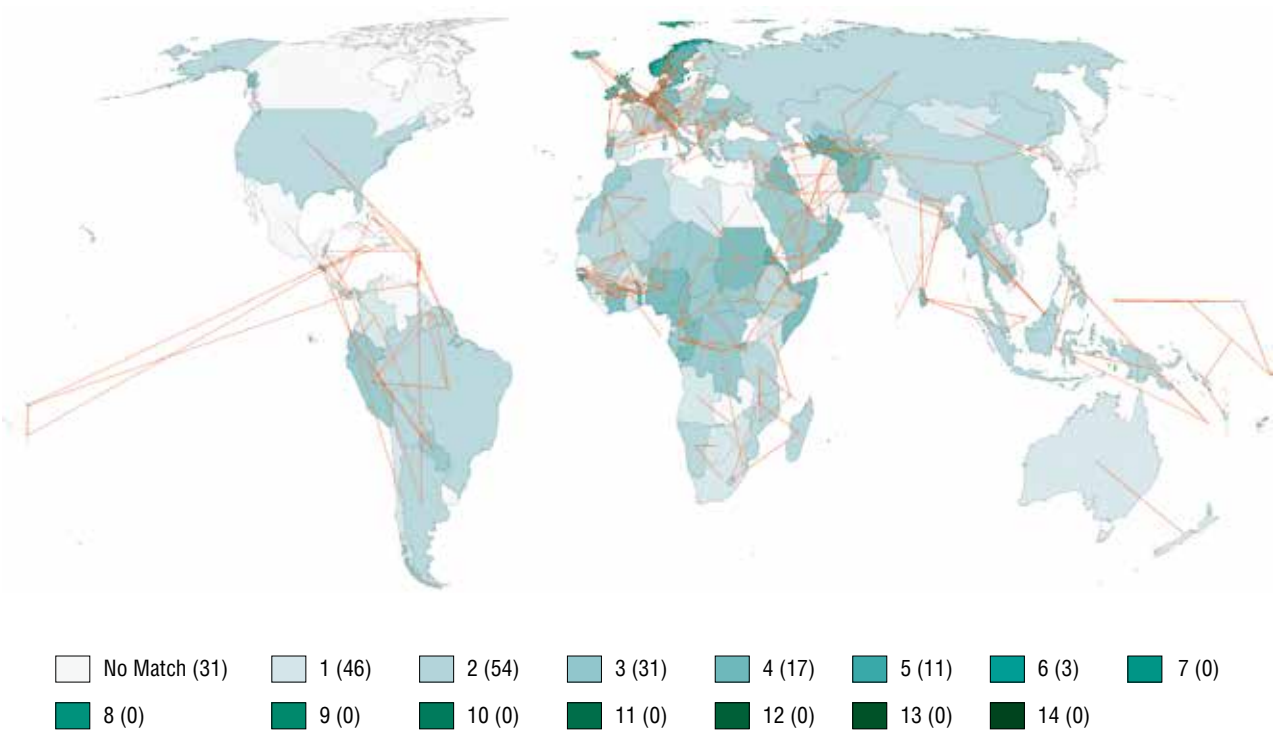


Fig. 5.1.2. Likelihood-ratio test for the “Institutional foundations of democracy” parameter

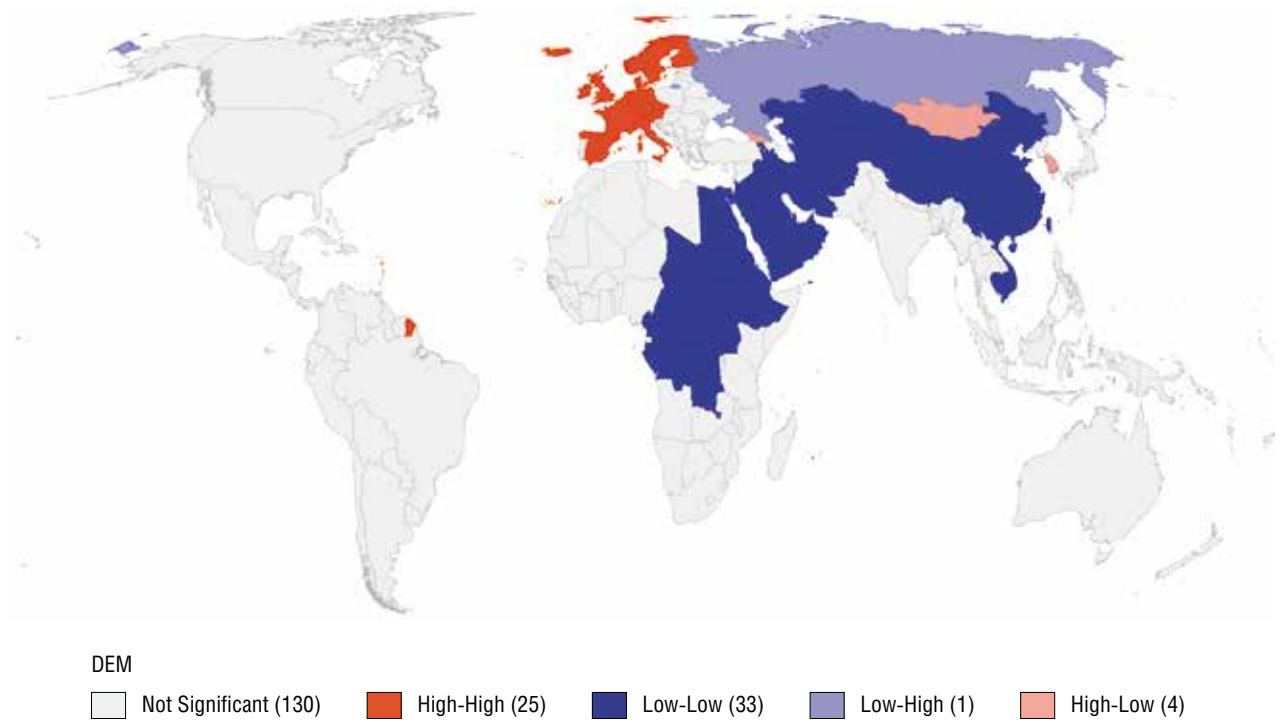


Fig. 5.1.3. “Institutional foundations of democracy” spatial autocorrelation cartogram for the geometric neighbourhood matrix

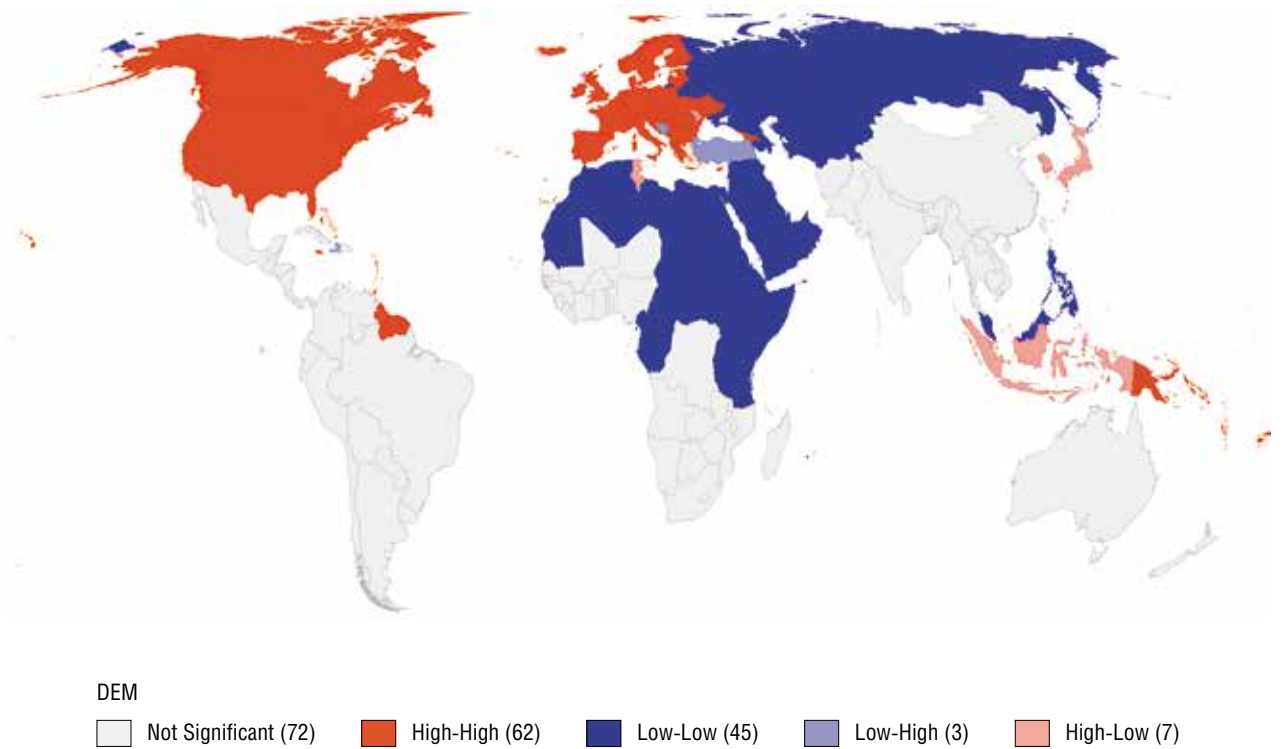


Fig. 5.1.4. “Institutional foundations of democracy” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.2. Voter turnout

Voter turnout is operationalized through voter turnout rates for parliamentary elections. Voter turnout reflects the legitimacy of the current system: the higher the index, the higher system's legitimacy. Let us note that, in this case, legitimacy is seen not as a construct elites use to legitimize their power even with low voter turnout, but as actual legitimacy (for more detail, see, for instance: Kirkland, Wood 2017).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.080	0.038	0.077	0.003
Geary's C	0.961	0.237	0.918	0.003

The percentile cartogram (Fig. 5.2.1) shows the highest voter turnout in two neighbouring countries: Vietnam and Laos. Both these countries have a single-party system (the Communist Party of Vietnam and the Lao People's Revolutionary Party), and the authorities use universal political mobilization for elections.

The countries with the lowest voter turnout are Benin and Haiti. In Benin, riots erupted throughout the country before the presidential elections. People were wounded and killed in clashes between citizens and police. Mistrust in the electoral process made for a low voter turnout. In Haiti, low voter turnout is due to the unrealistic promises of the candidates.

Low voter turnout is typically observed in the countries of the Maghreb. This may be due to general mistrust in the institute of elections and the existence of dominant parties that support incumbent heads of state. High voter turnout is typical for the countries of Northern Europe, Southeast Asia and Latin America.

The geometric neighbourhood matrix yields a slightly greater spatial correlation than the geopolitical matrix, and, consequently, the hypothesis that the world's geopolitical structure has greater significance is not confirmed. Let us note, however, that the spatial autocorrelation index for this indicator is small, although we may observe a weak positive correlation.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.2.3) shows two low-value clusters. The first included the Congo, Libya, the Central African Republic, Chad, Algeria, Egypt and Tunisia where the turnout is low both in the countries themselves and their neighbouring states. The second cluster is close to the first one and included Iraq and Iran. Turkey is an exception here, and we should note that it has boasted consistent high voter turnout since the 1980s. Political commentators in the country put this down to Turkey not having a strong civil society. Additionally, Israel also has a high voter turnout,

Global place	Country	Indicator
1	Vietnam	99.26
2	Laos	97.93
3	Singapore	95.81
Median (9)	(Nige	66.27 (66.26)
Mean (97)	(Estonia)	64.49 (63.67)
179	Egypt	29.07
180	Benin	22.98
181	Haiti	17.82

especially when compared to its neighbours. The 2018 presidential elections in Mauritania constituted the first relatively democratic power transfer from one president to another in the country's history, and, given the demand for such a change, the high voter turnout is easy to explain. Looking at Niger, considering that the data is for 2016, we should note that the country was the target of attacks by Boko Haram extremists at the time, and this certainly influenced the electoral agenda, which focused on matters of security and countering poverty. Let us note that even though Mahamadou Issoufou did not win an absolute majority of votes, he did emerge victorious in the second round, even though the opposition boycotted it.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 5.2.4) clearly shows two different clusters. The first is similar to the cluster in the geometric neighbourhood matrix. This is a cluster of low values that includes Syria, Sudan, Iraq, Jordan, Egypt and the countries of the Maghreb. An outlier here is Mauritania, which is classified as an “error,” i.e. voter turnout figures should have been low, yet, contrary to the neighbourhood effect, they proved to be high, which may be explained by President Mohamed Ould Abdel Aziz's resignation after two years in office. Mohamed Ould Ghazouani, the ruling party's candidate, came to power, which led to changes in electoral behaviour at parliamentary elections.

The second, high-value cluster spans the following Southeast Asian states: Indonesia, Thailand, Myanmar and the Philippines. As for “errors,” it is Japan, which, despite the population's active electoral involvement in the above-mentioned South Asian states, demonstrates low voter turnout. In 2014, the low voter turnout was due to economic recession, while in 2017, the opposition claimed the low turnout was due to Shinzo Abe's possible involvement in the scandal surrounding the Moritomo Gakuen and Kake Gakuen education organizations. Shinzo Abe resigned from office in 2020.

Chile and Colombia may also be classified as “errors” specifically because neighbouring states demonstrate high voter turnout, while Chile and Colombia have low turnout figures. At the same time, unlike in the geometric neighbourhood matrix, two countries stand out in terms of high voter turnout both in the country itself and in its neighbours — Venezuela, Peru and Paraguay.

As for a likelihood-ratio test for geometric and geopolitical neighbourhood for the “Voter turnout” parameter (Fig. 5.2.2), no stark connection nodes were identified. A relatively stable node may be observed in the countries of Western and Northern Europe only, while other global regions did not congeal into clusters, which attests to high differentiation between countries for this indicator.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Particulate air pollution	0.060	0.002	−0.2	0.670
2	Primary education enrolment	0.026	0.036	0.116	0.525
3	Loans to domestic companies	0.054	0.003	0.167	0.521
4	Conflictogenity	0.093	0.000	−0.213	0.488
5	Healthcare spending	0.033	0.016	0.114	0.398
6	Publication activity	0.031	0.019	0.106	0.364
7	Unemployment	0.079	0.000	−0.168	0.359
8	School education quality	0.053	0.003	0.136	0.347
9	Passport power	0.032	0.016	0.1	0.312
10	Military spending	0.047	0.008	−0.121	0.310

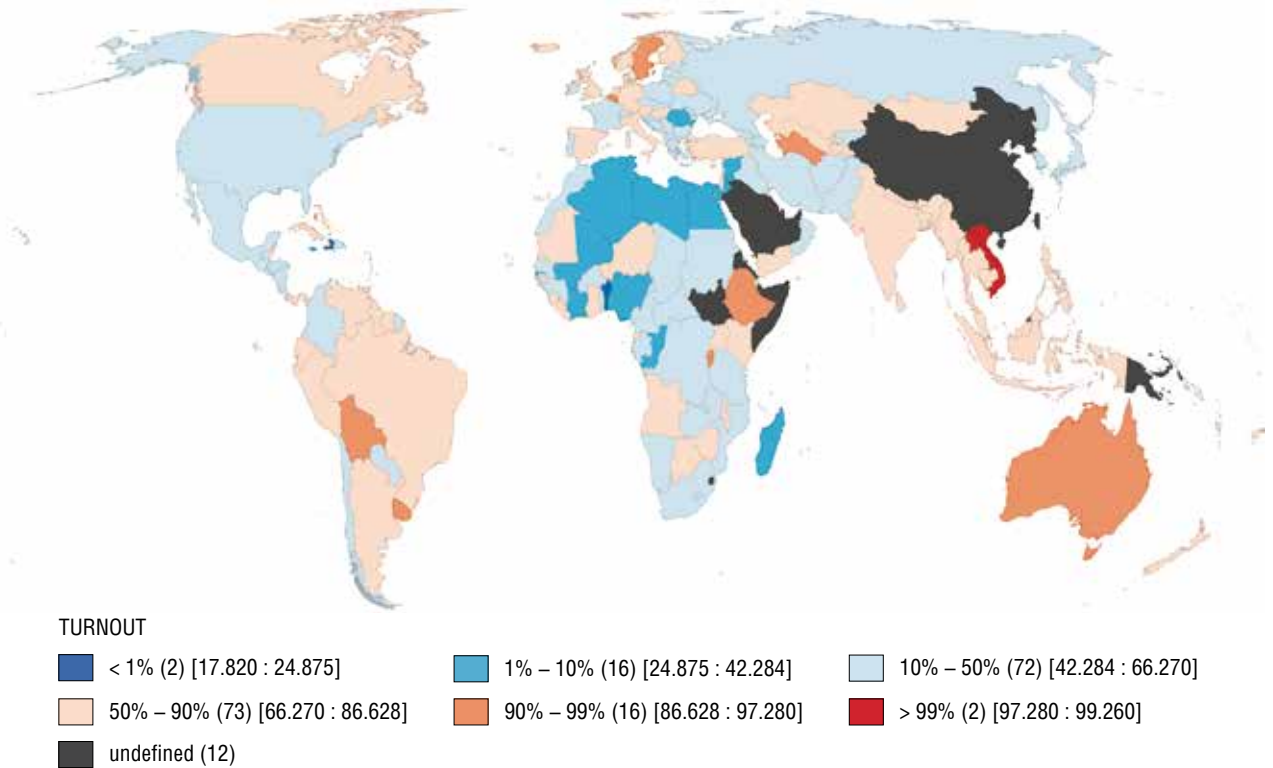


Fig. 5.2.1. Percentile cartogram for the “Voter turnout” indicator

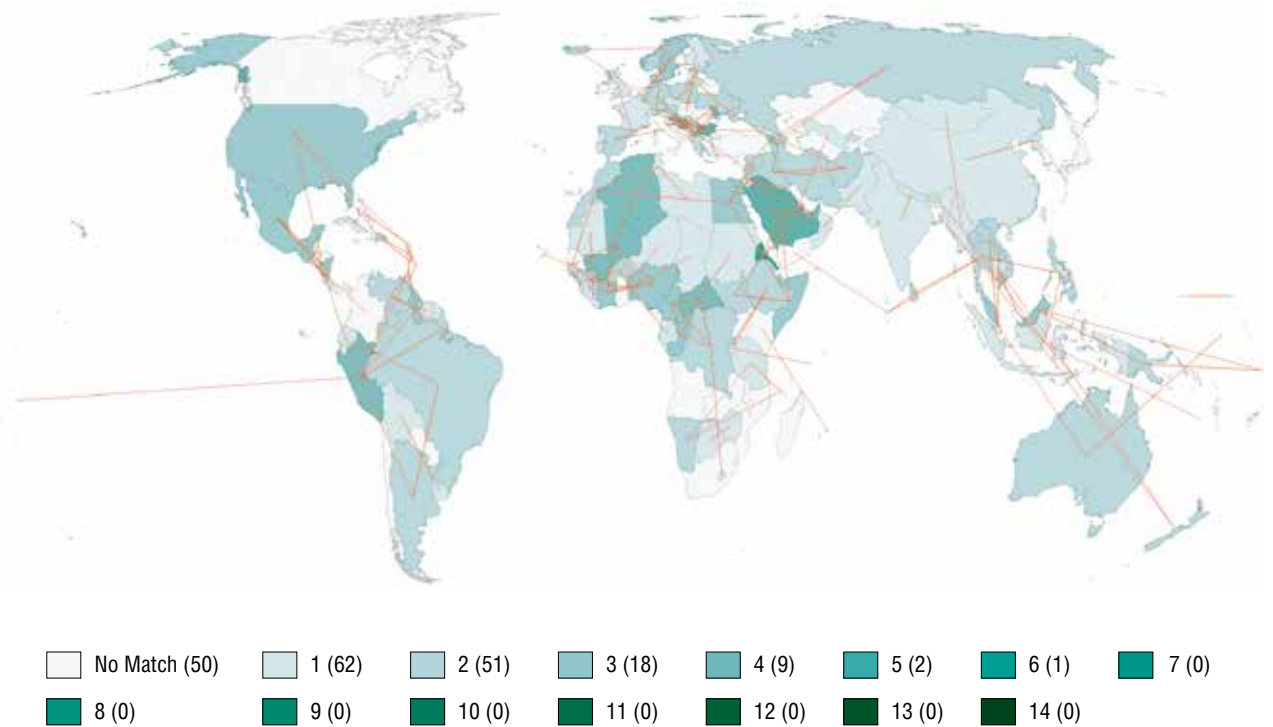


Fig. 5.2.2. Likelihood-ratio test for the “Voter turnout” parameter

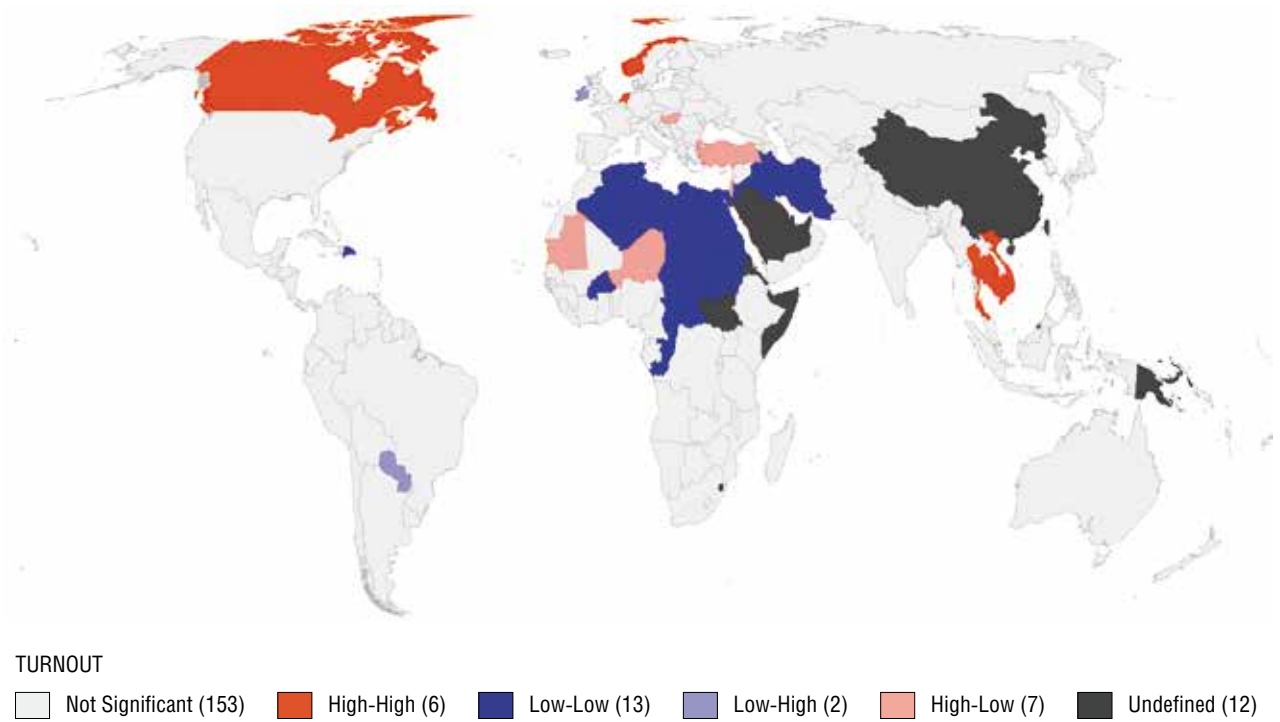


Fig. 5.2.3. “Voter turnout” spatial autocorrelation cartogram for the geometric neighbourhood matrix

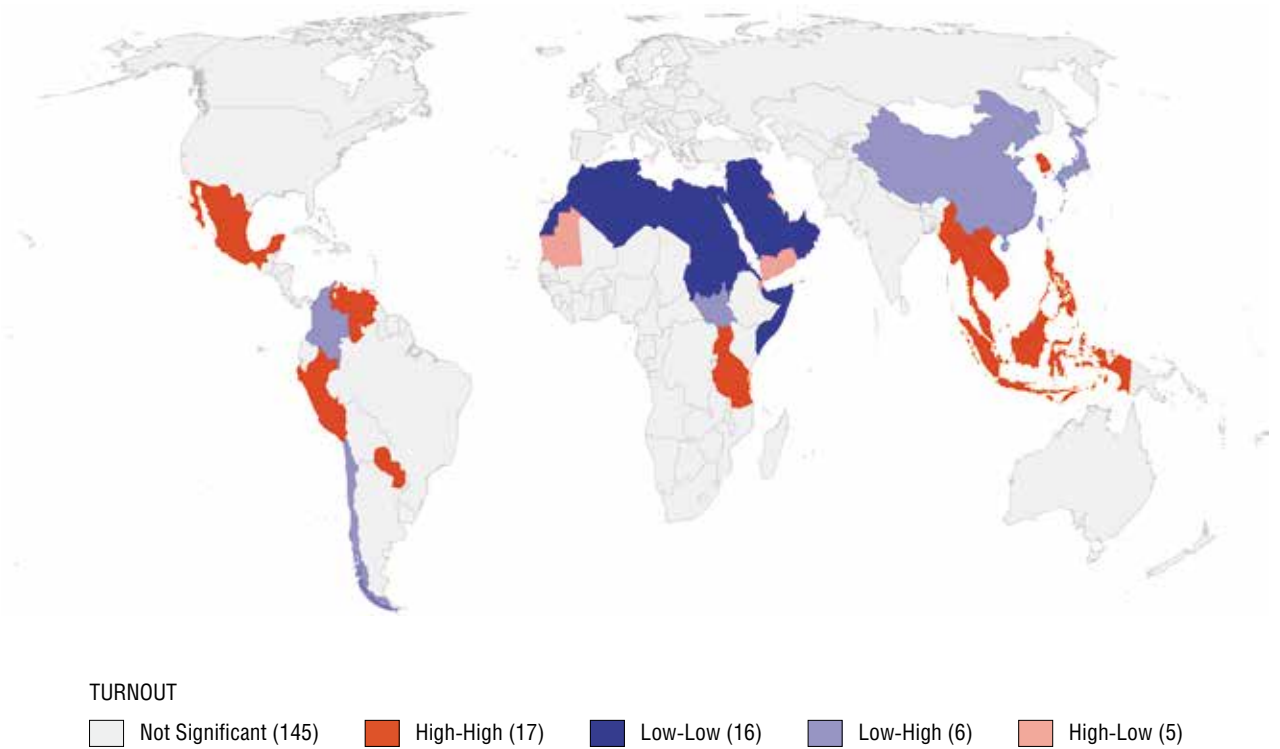


Fig. 5.2.4. “Voter turnout” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.3. Women in politics

This indicator measures the percentage of women in lower houses of parliaments throughout the world. It is important from the point of view of human capital and human development due to the trend towards equal opportunities for all members of society in various areas, including politics. The higher the gender representation of such a body as the parliament is, the more democratic the system is believed to be. Let us note that despite opponents claiming that granting preferences to women contradicts the equality principle and qualification-based elections, female representation in parliaments makes it possible to transform token representation into real representation. UN Women and the Inter-Parliamentary Union are engaged in gender equality issues internationally, and 1995 marked a watershed moment in this area following the signing of the Beijing Declaration and Platform for Action were signed that year.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.243	0.000	0.207	0.000
Geary's C	0.743	0.000	0.789	0.000

The percentile cartogram (Fig. 5.3.1) shows highest female representation in Cuba and Rwanda (in this case, this is due to the country's reformed politics and policies after the 1994 genocide). There are many female MPs in the parliaments of Mexico, France, Spain, the countries of Northern Europe, Bolivia, Nicaragua, New Zealand, Namibia, South Africa and Mozambique, which is due to female quotas in parliaments and individual parties. The smallest numbers of female MPs are in the parliaments of Iran, Oman, Yemen, Nigeria, Sri Lanka, Thailand and Papua New Guinea due to the cultural specifics and traditions of these countries.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and, consequently, the hypothesis that the world's geopolitical structure has greater significance is not confirmed for this indicator.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.3.3) shows three clusters. The first is a high-high-value cluster that includes the following European countries: Germany,

Global place	Country	Indicator
1	Rwanda	61.29
2	Cuba	53.20
3	Bolivia	53.10
Mean (87–89)	(Venezuela, Ireland, Uruguay)	22.18 (22.19)
Median (96–97)	(Bangladesh, Romania)	20.70 (2.69)
189	Oman	1.20
190	Yemen	0.30
191–193	Vanuatu, Micronesia, Papua New Guinea	0

Norway, Sweden, Spain, Denmark, Poland, Ireland, the United Kingdom, Finland and France. This cluster is characterized by high female parliamentary representation both in the countries themselves and in neighbouring states. The high female representation in these countries is due to candidate and political party quotas. The second small cluster of low-low values includes Saudi Arabia and Oman.

The geopolitical matrix cartogram (Fig. 5.3.4) features many more clusters. The first includes countries of Western and Northern Europe and North America, which means that these countries, which have long-standing democratic traditions, have high female representation both in the countries themselves and in their neighbours. The second cluster includes states of Eastern Europe and Turkey. Their proximity to European countries suggests that they should have high female parliamentary representation, but in fact the number of women in parliaments is lower and the neighbourhood effect did not work because of the traditions in these states and their largely patriarchal way of life.

The next cluster includes East African countries, excluding Guinea (which has higher values than its neighbours even though, following the neighbourhood effect logic, it should have low values). A high-value cluster in Africa includes Ethiopia, South Sudan, Tanzania and Uganda. Kenya represents an exception in this cluster, as the number of women in its parliament is low. A low-value cluster emerged in Latin America that includes Brazil, Colombia and Venezuela unaffected by their neighbours, where female representation in parliaments is high.

A comparison of two cartograms suggests that the geopolitical neighbourhood matrix cartogram shows more clusters whose outlines follow those of different global regions united by their similar characteristics.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Women in politics” parameter (Fig. 5.3.2) shows connections between European states that have various quotas for female involvement in politics. Countries of the Caribbean also demonstrate similar values for this indicator; there is a connection between African and Middle Eastern countries due to similar traditions of female involvement in the political life of the state.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Healthcare spending	0.085	0.000	0.355	1.486
2	Passport power	0.050	0.002	0.245	1.204
3	Institutional foundations of democracy	0.023	0.033	0.167	1.187
4	Conservation areas	0.046	0.003	0.225	1.098
5	Years at school	0.034	0.012	0.187	1.023
6	Particulate air pollution	0.098	0.000	−0.298	0.903
7	Regional trade agreements	0.080	0.000	0.267	0.895
8	GDP (PPP) per capita	0.036	0.009	0.175	0.842
9	Renewable energy	0.065	0.000	0.226	0.783
10	Internet users	0.048	0.002	0.188	0.734

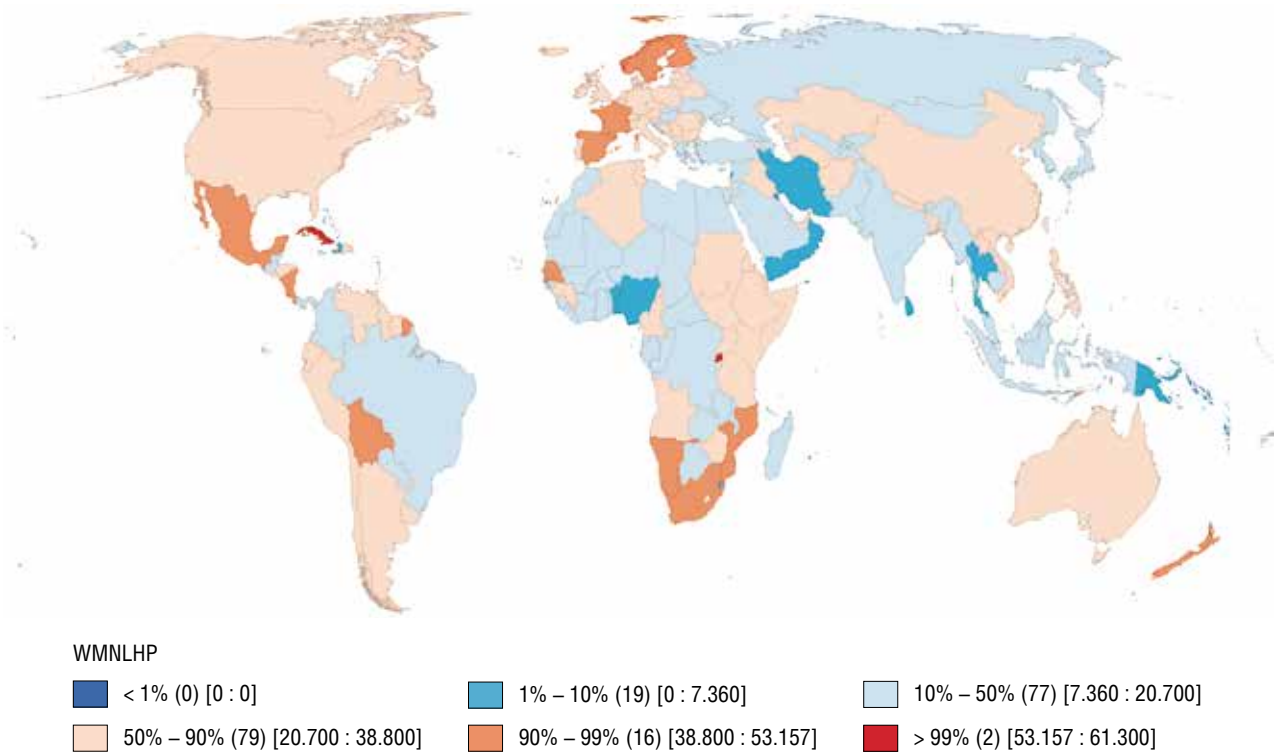


Fig. 5.3.1. Percentile cartogram for the “Women in politics” indicator

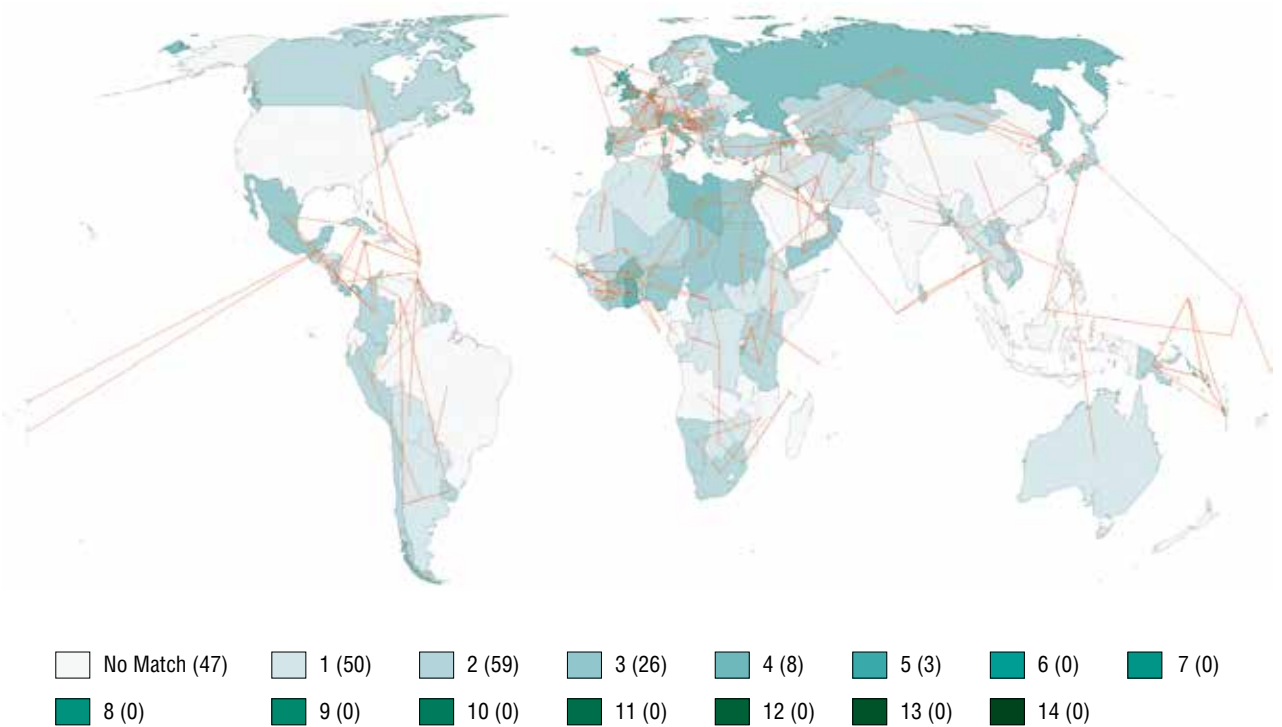


Fig. 5.3.2. Likelihood-ratio test for the “Women in politics”

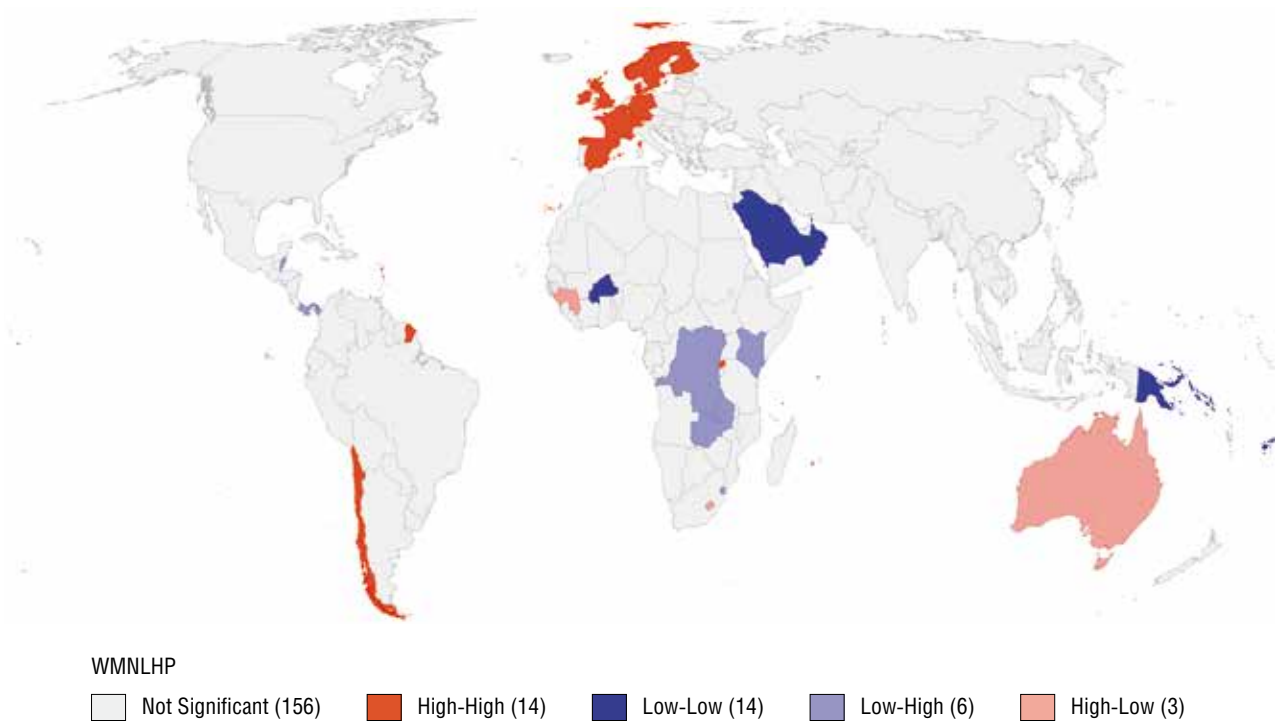


Fig. 5.3.3. “Women in politics” spatial autocorrelation cartogram for the geometric neighbourhood matrix

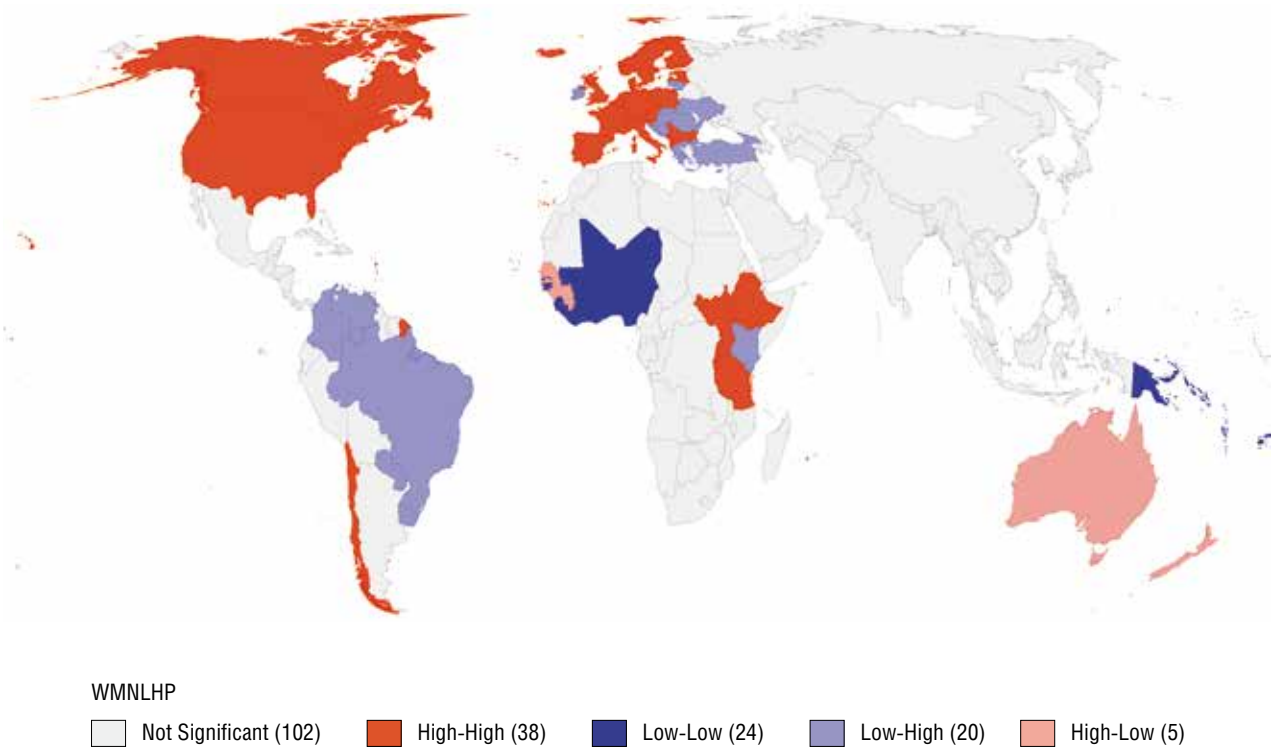


Fig. 5.3.4. “Women in politics” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.4. Public organizations

Non-profit organizations are important for understanding the political processes in a society since non-profits may be involved in political decision-making and form the core of civil society. Additionally, non-profits provide those public goods that are not provided by the state or commercial organizations because of their non-profitability. They may influence public opinion in a given state.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.025	0.119	0.020	0.055
Geary's C	0.868	0.239	0.975	0.055

The percentile cartogram (Fig. 5.4.1) shows that the United States and Poland have the world's largest numbers of non-profits. Virtually every state in the world has non-profits, yet several "islands" stand out, for example, the countries of Central Asia, the Middle East and Northeast Africa. Islam probably is the reason why these states have relatively few non-profits. First, instead of non-profits, Muslim countries have Muslim charities that, in particular, see "Islam as the solution," meaning that the religion may help solve not only moral and ethical problems, but also economic and political ones (the maximalist approach to religion). Consequently, these countries do not need to create additional legal institutions to implement civil rights and freedoms such as those developed in the West, because Islam handles all those issues (this claim is not an attempt to idealize Islam, it merely emphasizes a unique approach to resolving certain matters in the realm of human rights and freedoms, even though Western states believe that civil rights are frequently violated in Muslim countries). Let us, however, stress that this does not mean that Muslim countries do not have any non-profits at all. Muslims do not view non-profits as an instrument that allows the rich to help the poor. Rather, they view them as an instrument that allows the poor to realize their God-given right and the rich to carry out their God-assigned duty, which fits into the Islamic traditions of fair re-distribution.

Also let us note that the mean value is significantly higher than the median value. This is primarily because of the United States and its high number of non-profits, which exceeds the number of non-profits in any other state by an order of magnitude.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.4.3) shows one clear cluster of states with large numbers of non-profits. This cluster includes the United Kingdom, Germany, France, Belgium and the Netherlands. This high-value cluster emerges because these states strive for stability, and it prompts them to form such mechanisms for public participation and the implementation

Global place	Country	Indicator
1	US	21,903.00
2	Poland	7,548.00
3	UK	4,100.00
Mean (21)	(Cameroon)	293.47 (283.00)
Median (93)	Georgia	34.00
170–171	Palau, Saint Kitts and Nevis	3.00
172–177	Brunei, Bhutan, Oman, Suriname, San Marino, Tonga	2.00
178–185	East Timor, Guinea Bissau, Djibouti, North Korea, Kiribati, Micronesia, Equatorial Guinea, Eritrea	1.00

of a political course that would account for and coordinate the entire range of various interests. At the same time, there is a clearly identifiable cluster of states with small numbers of non-profits: the Czech Republic, Slovakia and Slovenia. The number of non-profits in Slovakia is falling as control over their activities is tightening compared to the 1990s. This policy has been implemented because the Slovakian authorities (starting with Robert Fico, Prime Minister in 2006–2010 and 2012–2018) suspect non-profits of not acting in the interests of the country. The same is true for Slovenia. In the Czech Republic, populists are the main actors fighting against non-profits.

The geopolitical neighbourhood matrix cartogram (Fig. 5.4.4) shows a large number of clusters. One low-low cluster includes states of Northern and Eastern Europe, as well as Turkey, all of which have low numbers of non-profits, just like their neighbours. A similar cluster includes states of Southern Africa, which also have small numbers of non-profits (an exception here is South Africa, which comes out as an “error” and, contrary to its neighbours, has many non-profits because of its high sociopolitical development). Two further clusters also have an extensive network of non-profits even though their neighbours have few non-profits of their own. Also let us note certain “error” categories: the first group includes states of Western Europe (with the exception of Spain, Portugal and Ireland), the United States and Canada. The second cluster with similar features is situated in South Asia and includes India, Pakistan, Bangladesh and Nepal. This is because, among other things, these states have high public activity indicators due to their traditions of providing assistance and good neighbourliness. India, for instance, has such concepts as “selfless service” and “alms” that form the foundation of India’s civil society. These concepts, in turn, have their roots in Hinduism, which emphasizes people’s service to each other.

A comparison of two cartograms suggests that the geopolitical neighbourhood matrix identifies more clusters for this indicator that divide the world into several parts: it divides Europe into Eastern and Western parts and also highlights African states with undeveloped non-profits.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Public organizations” parameter (Fig. 5.4.2) shows several clusters of similar states. First, there is a cluster of European states. Similar indicator values are observed in the states of the Middle East, states of Central and South Africa, the Caribbean, and South America. Finally, similar indicators unite states of Southeast Asia.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Bioethical freedom	0.024	0.049	0.171	1.194
2	School education quality	0.024	0.047	0.133	0.744
3	Elderly population	0.023	0.041	0.107	0.492
4	Years at school	0.028	0.024	0.111	0.441
5	Passport power	0.024	0.036	0.101	0.428
6	Tertiary education enrolment	0.024	0.049	0.091	0.340
7	Publication activity	0.033	0.014	0.103	0.326
8	Medium- and hi-tech sectors	0.031	0.034	0.1	0.324
9	CO ₂ emissions	0.025	0.036	0.086	0.300
10	GDP (PPP) per capita	0.032	0.016	0.096	0.288

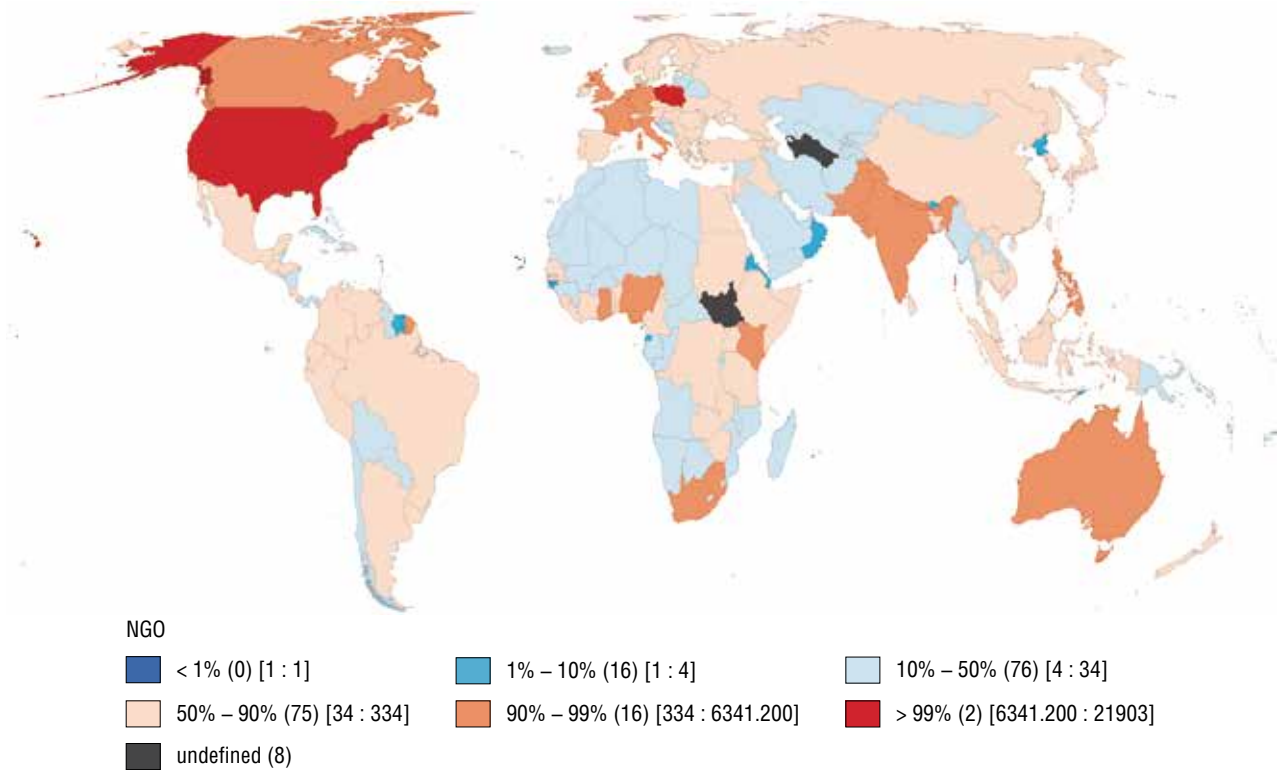


Fig. 5.4.1. Percentile cartogram for the “Public organizations” indicator

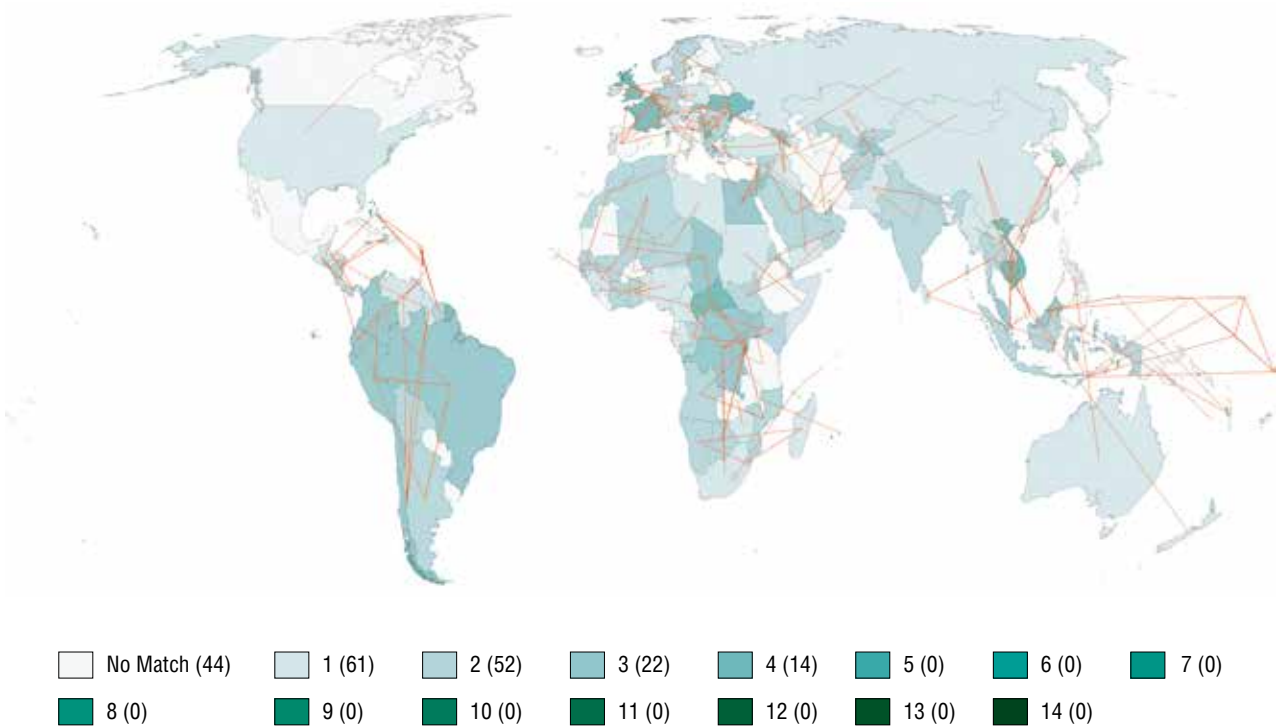


Fig. 5.4.2. Likelihood-ratio test for the “Public organizations” parameter

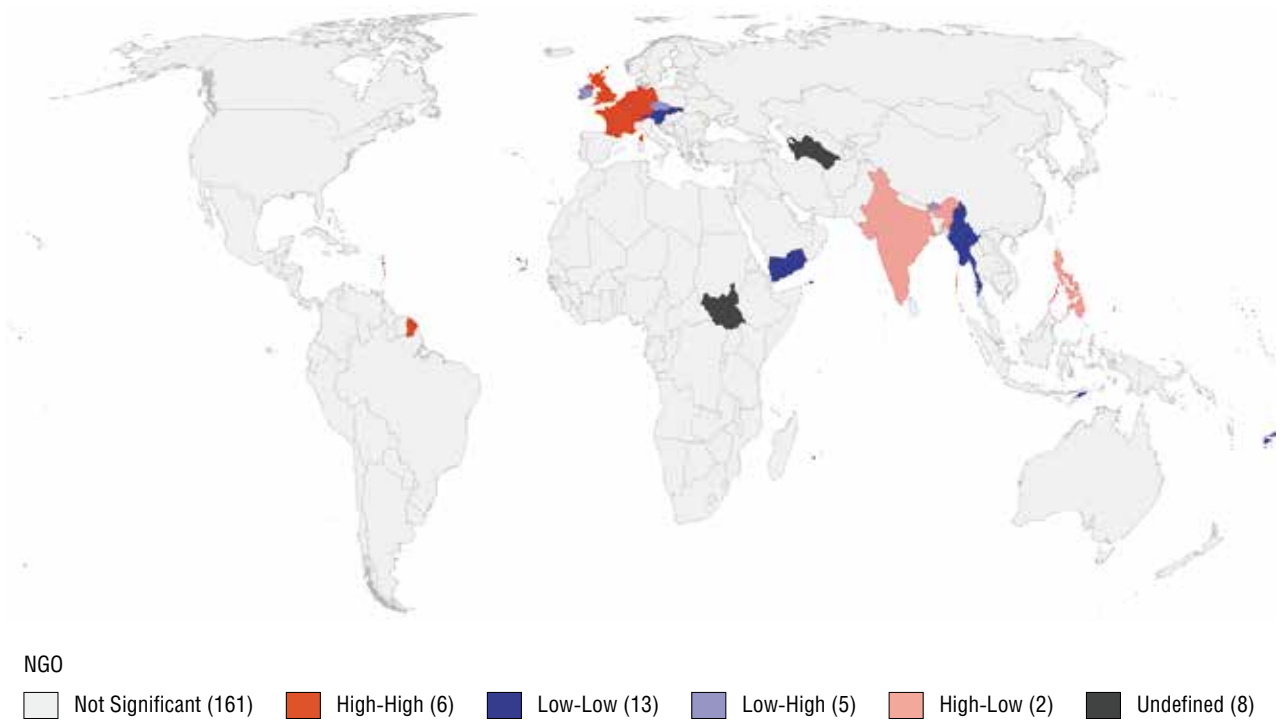


Fig. 5.4.3. “Public organizations” spatial autocorrelation cartogram for the geometric neighbourhood matrix

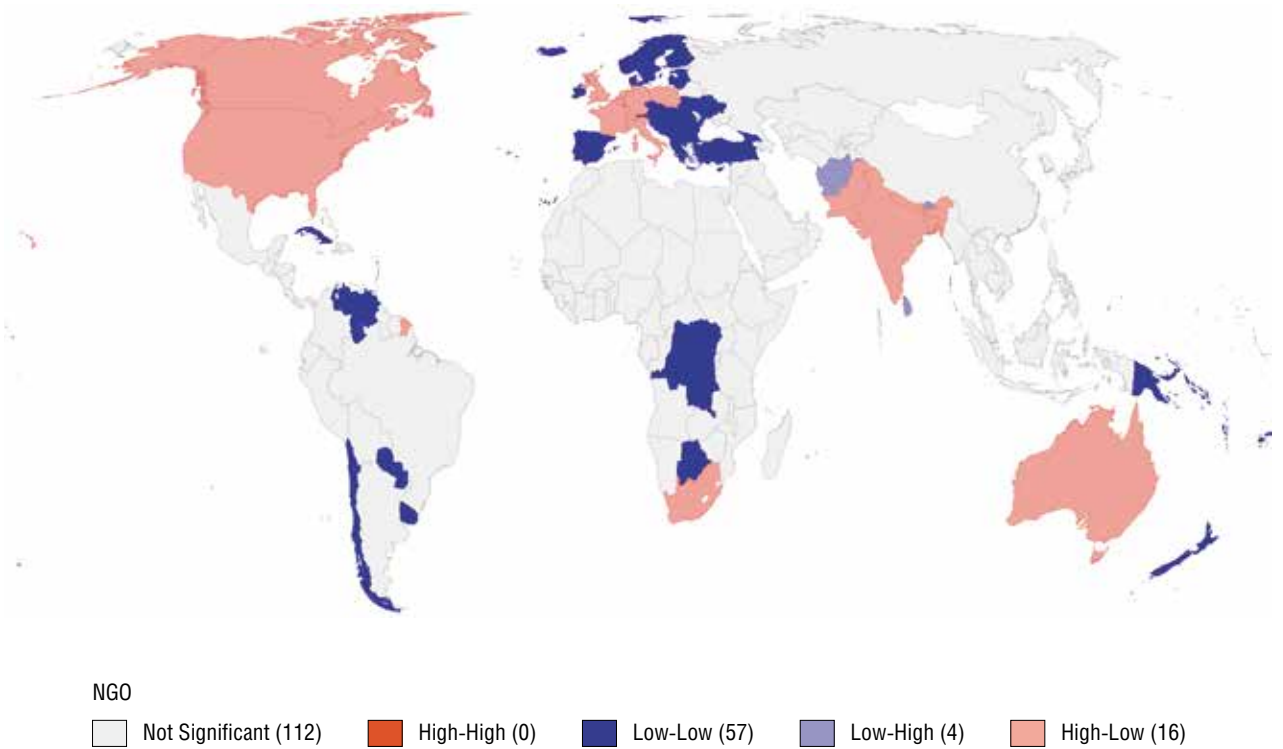


Fig. 5.4.4. “Public organizations” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.5. Corruption

The corruption perceptions index suggests how transparent people believe their country's decision-making process is and how quickly in their opinion such decisions may be made. It is important to remember that the higher the corruption perceptions index is, the less corrupt a country is considered to be, while the lower the index, the more corrupt the state.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.385	0.000	0.187	0.000
Geary's C	0.587	0.000	0.809	0.000

The percentile cartogram (Fig. 5.5.1) shows that states can be notionally divided into two large groups. The first includes the states of Europe and North America (with the exception of Mexico), where corruption is low (and the index, accordingly, has higher values). The second group includes most states in the world, specifically, almost all the countries of Africa, Central Asian states and Russia.

There is a separate cluster of states with low corruption levels: Saudi Arabia (for instance, in 2017, Crown Prince Mohammed bin Salman launched a major anti-corruption review when suspects were detained without clear legal grounds), India (which implemented "demonetization" as part of its anti-corruption policy), China (where corruption is punishable by criminal prosecution or death), Indonesia (in 2002, Indonesia established an Anti-Corruption Commission; information about commercial activities of Jakarta's government is published on social networks; Indonesia also uses GRANTIs, an app designed to prevent corruption and bring it home to people that "free gifts" are also a form of corruption), and Australia (which has anti-corruption commissions and also employs territory-based multi-level criminal policy that distributes anti-corruption powers throughout every level of authorities).

Finally, South America is also split into the states of the corrupt North and non-corrupt South.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix. Consequently, the hypothesis that the world's geopolitical structure has greater significance is not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.5.3) shows a cluster of European states with low corruption levels where governments use different anti-corruption methods, ranging from criminal prosecution to paying high wages to public officials (the idea being that if an official takes a bribe, they lose their high salary). Neighbouring Russia is an exception: due to the neighbourhood effect, it should have a low level of corruption, while in fact it is higher than in European countries,

Global place	Country	Indicator
1–2	Denmark, New Zealand	87.00
3	Finland	86.00
4–6	Singapore, Sweden, Switzerland	85.00
Mean (72–74)	(Bulgaria, Tunisia, Jamaica)	42.89 (43.00)
Median (89–90)	Serbia, Turkey	39.00
175	Syria	13.00
176	South Sudan	12.00
177	Somalia	9.00

which prevented it from becoming part of the European cluster. The next cluster includes countries of Central Africa where every state (with the exception of Burundi and Rwanda, where corruption levels are lower than in their neighbouring states — the ones that form the cluster under consideration) has a high level of corruption due to the high level of poverty and social inequality in these countries. A small cluster of states with high corruption levels also includes Uzbekistan and Afghanistan.

The clusters undergo certain changes on the geopolitical neighbourhood matrix cartogram (Fig. 5.5.4). Countries of the collective West, the United States and Canada clearly stand out: they have low levels of corruption and score high on the corruption perceptions index. The next cluster includes a small number of states where corruption levels should be low due to their proximity to European states and the neighbourhood effect, but in fact they have high levels of corruption: Ukraine, Turkey, Albania, Bulgaria, Bosnia and Herzegovina, Serbia, and Macedonia. These states are “errors” of the western cluster, and they have weak control over state governance and corruption.

Another cluster of states with high levels of corruption includes the Congo, the Central African Republic, Cameroon and Gabon. This cluster has changed compared to the geometric neighbourhood cartogram. Let us note that Cameroon is a very poor state, and it is corrupt at all levels of power. The Central African Republic has for many years been riven by civil war; military coups exacerbated by political chaos have become the norm, and various regions of the country are ruled by armed groups. In Gabon, the family of President Ali Bongo has been ruling the country since 1967, even though the corrupt practices of the president’s father have been repeatedly exposed. Additionally, Gabon is rich in oil, gas, and ore. In addition to its oil resources, the Congo’s anti-corruption legislation does not extend to officials and their family members and to members of political parties. Consequently, the countries in this cluster are similar either in that they are experiencing civil war and political instability, or in that they have oil resources and a single ruler who has been in power for an inordinate amount of time, which typically leads to the spread of corruption.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Corruption” parameter (Fig. 5.5.2) revealed a cluster of European states with similarly low corruption levels. There is also a cluster of African states that, on the contrary, have traditionally high corruption levels. Curiously, there are no other clusters clearly defined by this parameter, which demonstrates the world’s high differentiation as far as this indicator is concerned.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Cultural solidarity	0.046	0.007	0.242	1.263
2	Linguistic diversity	0.060	0.001	-0.266	1.180
3	Ethnic fractionalization	0.052	0.005	0	1.040
4	Ethnic minorities	0.063	0.001	-0.244	0.949
5	Population growth	0.106	0.000	-0.281	0.744
6	Highly wealthy population	0.126	0.000	-0.304	0.736
7	Economic inequality	0.095	0.000	-0.262	0.719
8	IMF voting power	0.085	0.000	0.246	0.715
9	Inbound tourism	0.092	0.000	0.25	0.678
10	Particulate air pollution	0.215	0.000	-0.37	0.637

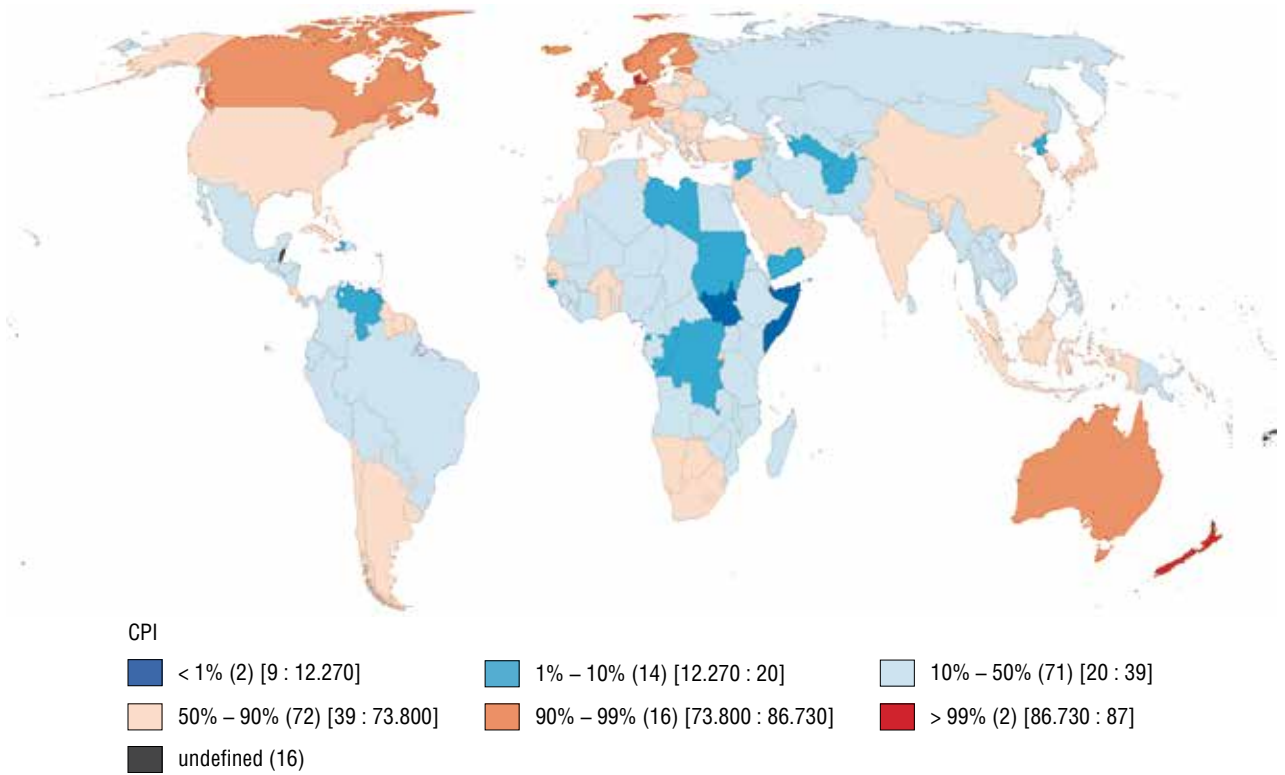


Fig. 5.5.1. Percentile cartogram for the “Corruption” indicator

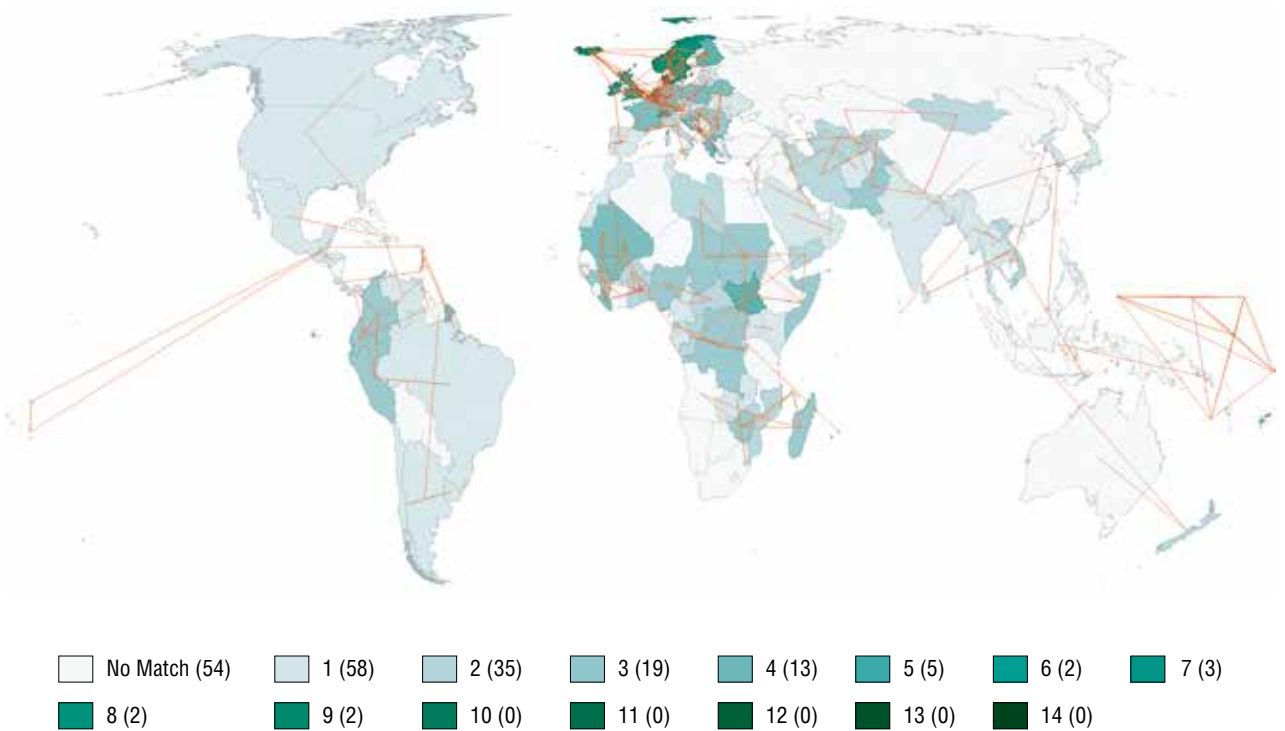


Fig. 5.5.2. Likelihood-ratio test for the “Corruption” parameter

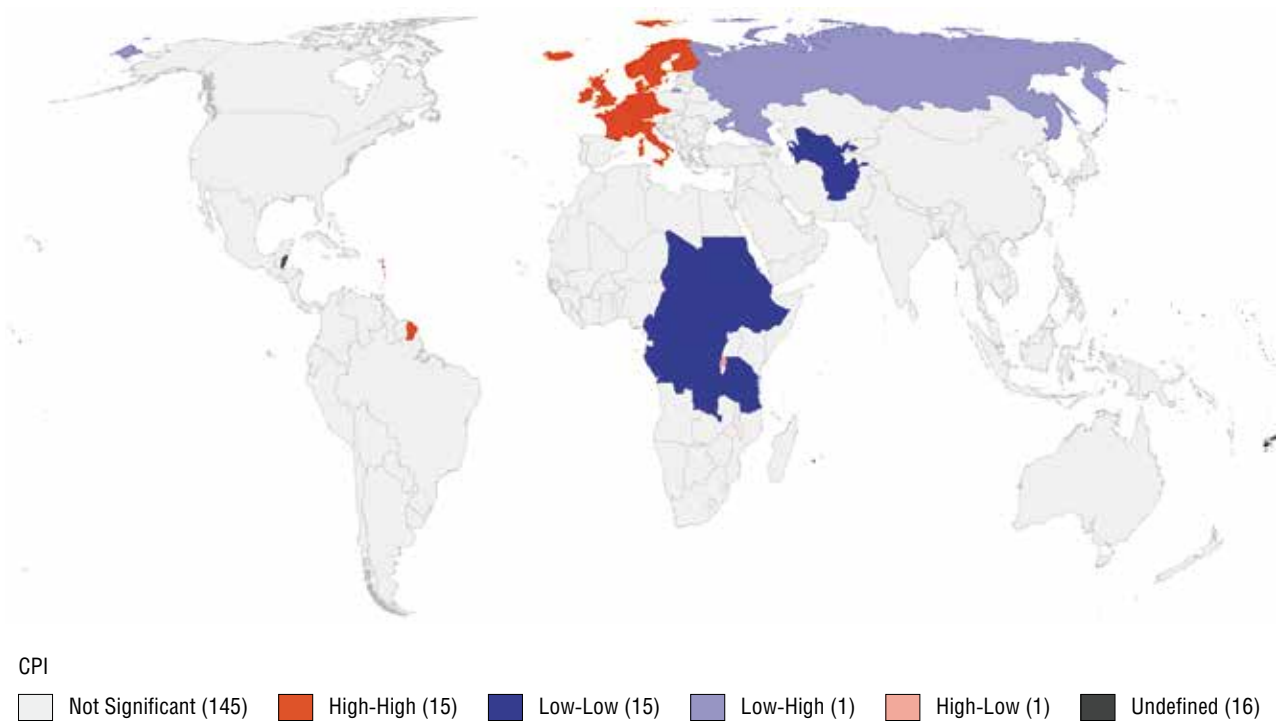


Fig. 5.5.3. “Corruption” spatial autocorrelation cartogram for the geometric neighbourhood matrix

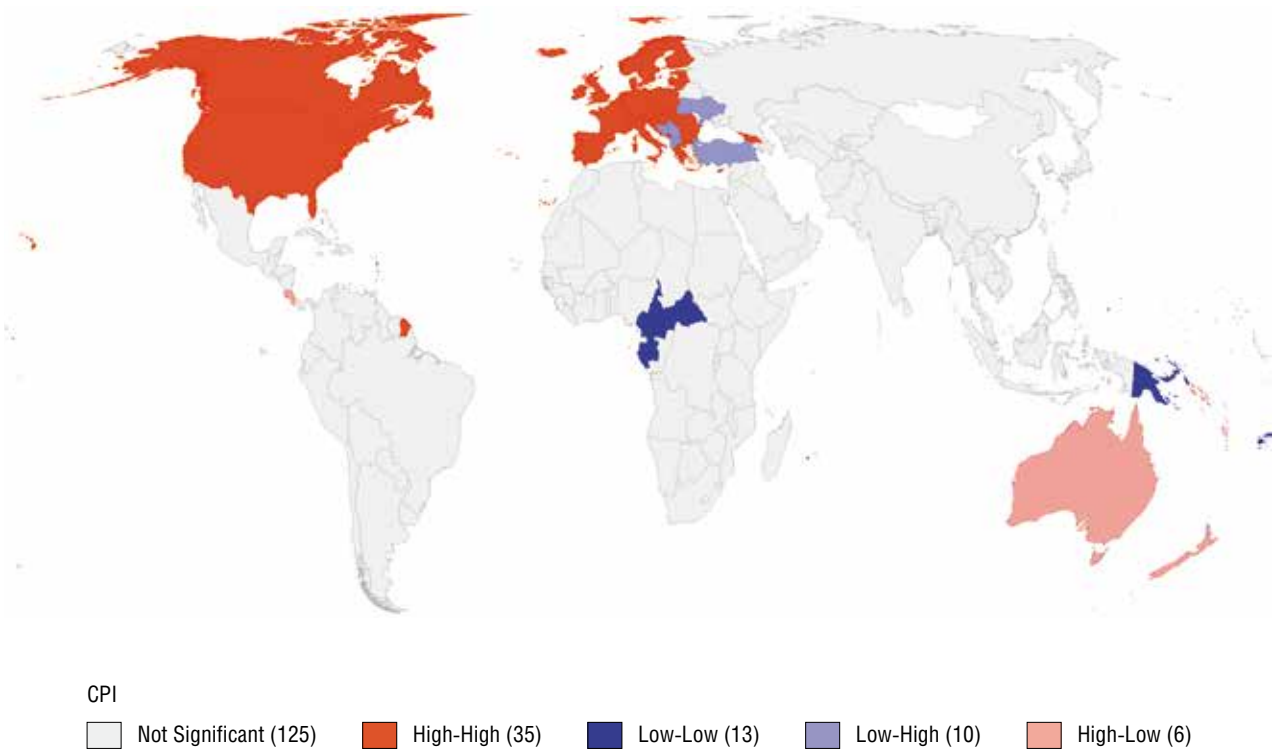


Fig. 5.5.4. “Corruption” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.6. IMF voting power

A state's voting power in the IMF's board of directors is a sign of its influence on the global economic system, a recognition of sorts of the country's power and influence, including its political influence.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.154	0.000	0.055	0.007
Geary's C	0.867	0.162	0.941	0.007

The percentile cartogram (Fig. 5.6.1) shows that, in addition to the United States and Japan, which have the largest share of votes in the IMF, there are other major global political actors, such as Brazil, Russia, India, China, Saudi Arabia, Canada, Australia, South Korea, Mexico, and the countries of Western Europe. This is almost the entire G20 — the group of countries with the most developed and developing economies (with the exception of Argentina, Indonesia, Turkey and South Africa). Let us note that this distribution became visible after the IMF quota system was reformed in 2016.

The other end of the spectrum has a belt of African states with low IMF voting power: Ethiopia, South Sudan, Sierra Leone, Guinea, the Central African Republic, Sudan, Mali, Chad, Cameroon, Gabon, Niger, Mauritania and Somalia, which is due to their low economic development and a whole range of domestic political problems.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.6.3) shows a cluster of high-value states both in a single given state and in its neighbours. This cluster includes the United States, Canada, Norway, France, Germany, the United Kingdom, Ireland and Japan. Essentially, the core of this cluster is formed by G7 states minus Italy. An exception here is Russia, which scores low on the indicator despite its European neighbours demonstrating high values. This is due to Russia's IMF quota, which will continue to be small even after it is revised.

Global place	Country	Indicator
1	US	17.44
2	Japan	6.48
3	China	6.41
Mean (35)	Nigeria	0.52
Median (95–99)	Afghanistan, Jordan, Iceland, Latvia, Senegal	0.07
176–181	Grenada, São Tomé and Príncipe, Tonga, Samoa, Saint Kitts and Nevis, Eritrea	0.003
182–185	Dominica, Kiribati, Micronesia, Saint Vincent and the Grenadines	0.002
186–189	Nauru, Marshall Islands, Palau, Tuvalu	0.001

On the geopolitical neighbourhood matrix cartogram (Fig. 5.6.4), clusters undergo certain changes. There is a cluster of states of the so-called collective West with high IMF voting power that also includes China (which, after the IMF reform, will be able to oppose the United States in the Fund and thus gain advantages for itself) and Brazil, due to its privileged IMF standing: the Fund cites Brazil as an example of how to implement a successful anti-inflation policy.

Against this background, a standout cluster includes Latin American states with low IMF voting power (compared to more socioeconomically developed Brazil and Argentina): these are Peru, Chile, Bolivia, Paraguay, Uruguay, Ecuador, Suriname and Guiana, which is due to their smaller IMF quotas. The next low-value cluster includes countries of Eastern Europe, which is also due to the lower economic indicators of these states, which are significantly below those of the developed economies that are their immediate neighbours.

Generally, the geopolitical neighbourhood matrix can be said to divide Latin America into two opposite clusters. The starkest division is that of Europe into the developed Western Europe and the less developed Eastern Europe. Let us also note that Southeast Asia also demonstrates a regional division. However, the division of states into those with greater voting power (Indonesia, Malaysia and Thailand) and those with lesser voting power (Vietnam, Cambodia, Laos, Myanmar and the Philippines) can be linked to the countries in the first group being among those most deeply involved in global trade, unlike those in the second group.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “IMF voting power” parameter (Fig. 5.6.2) reveals the same two European clusters with similar values, namely, a cluster of Western European states and a cluster of Eastern European states. There are also clusters of Middle Eastern states, of the Caribbean, of ASEAN states, and a cluster of sub-Saharan states.

Curiously, there is no EAEU cluster, which demonstrates high differentiation of EAEU members.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Suicide rate	0.037	0.013	0.202	1.093
2	Particulate air pollution	0.028	0.036	-0.169	1.036
3	Number of doctors	0.063	0.001	0.234	0.864
4	Access to electricity	0.030	0.016	0.154	0.781
5	Maternal mortality	0.031	0.017	-0.151	0.728
6	Bioethical freedom	0.086	0.000	0.245	0.696
7	School education quality	0.102	0.000	0.261	0.669
8	Secondary education enrolment	0.041	0.009	0.166	0.668
9	Infant mortality	0.051	0.002	-0.183	0.657
10	Regional trade agreements	0.054	0.001	0.187	0.645

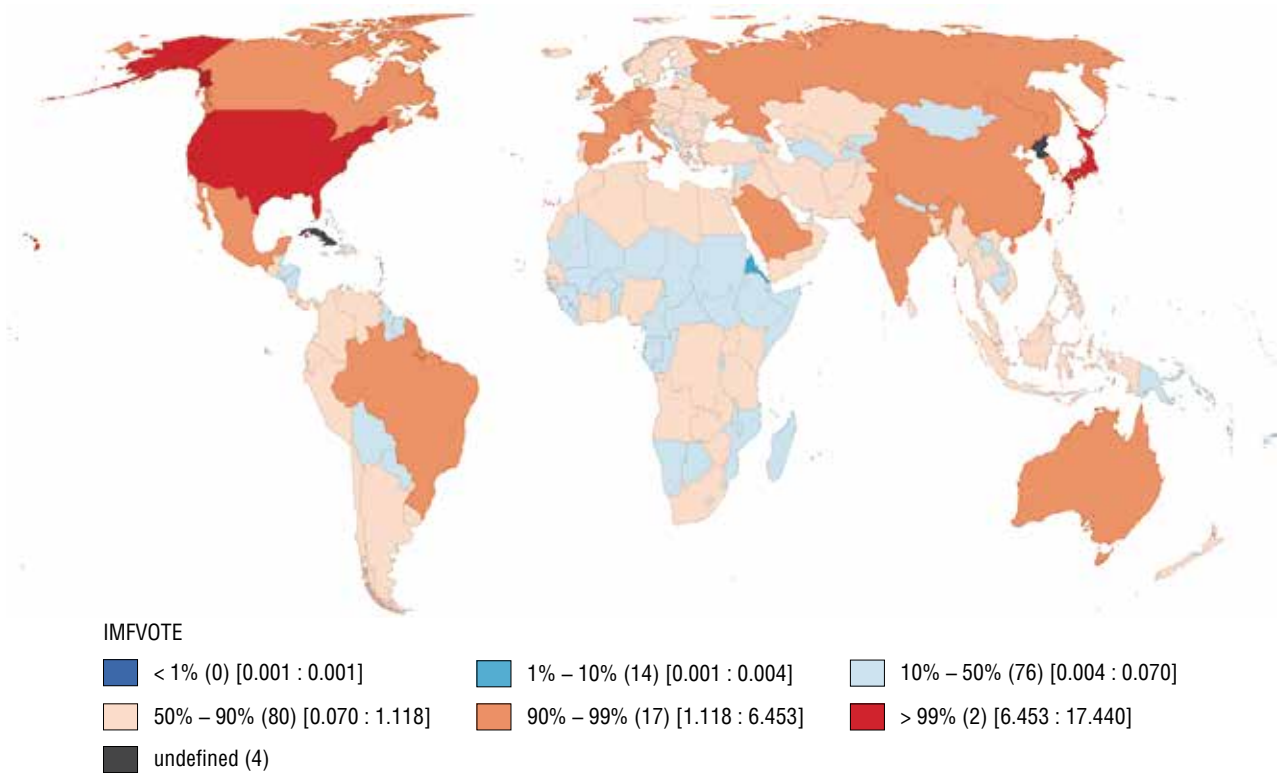


Fig. 5.6.1. Percentile cartogram for the “IMF voting power” indicator

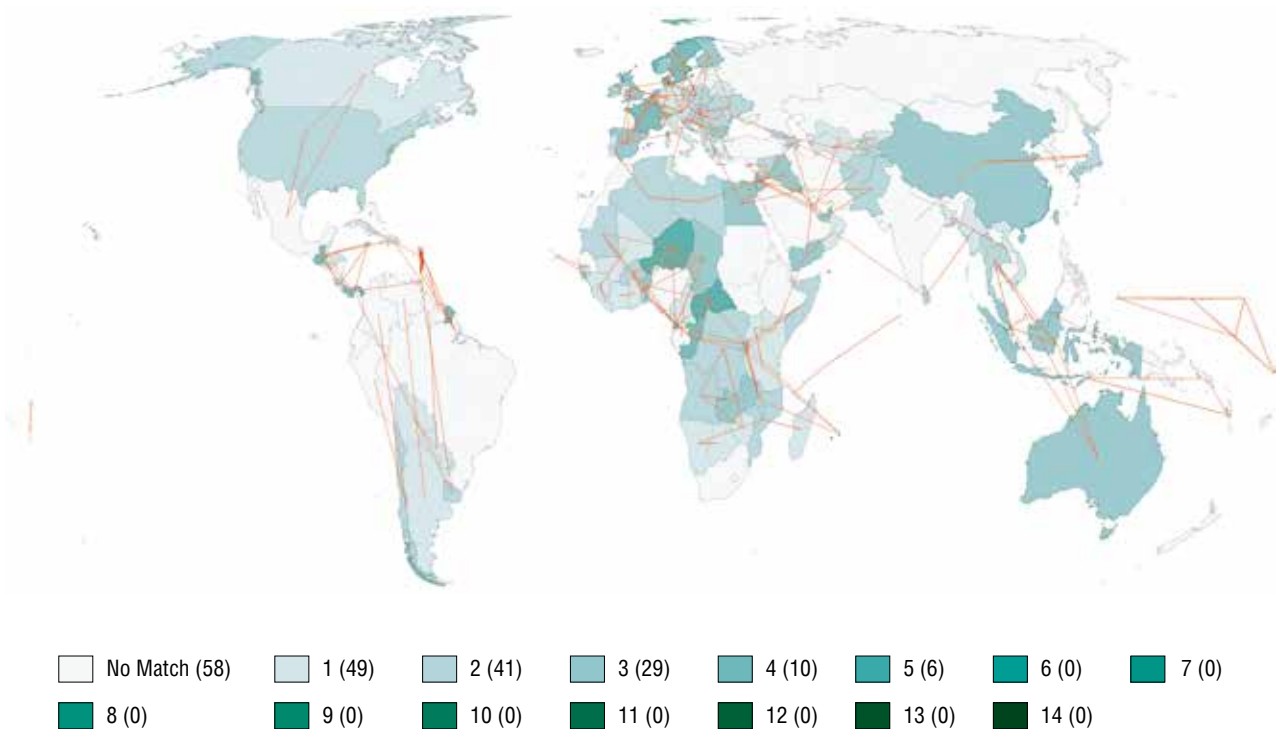


Fig. 5.6.2. Likelihood-ratio test for the “IMF voting power” parameter

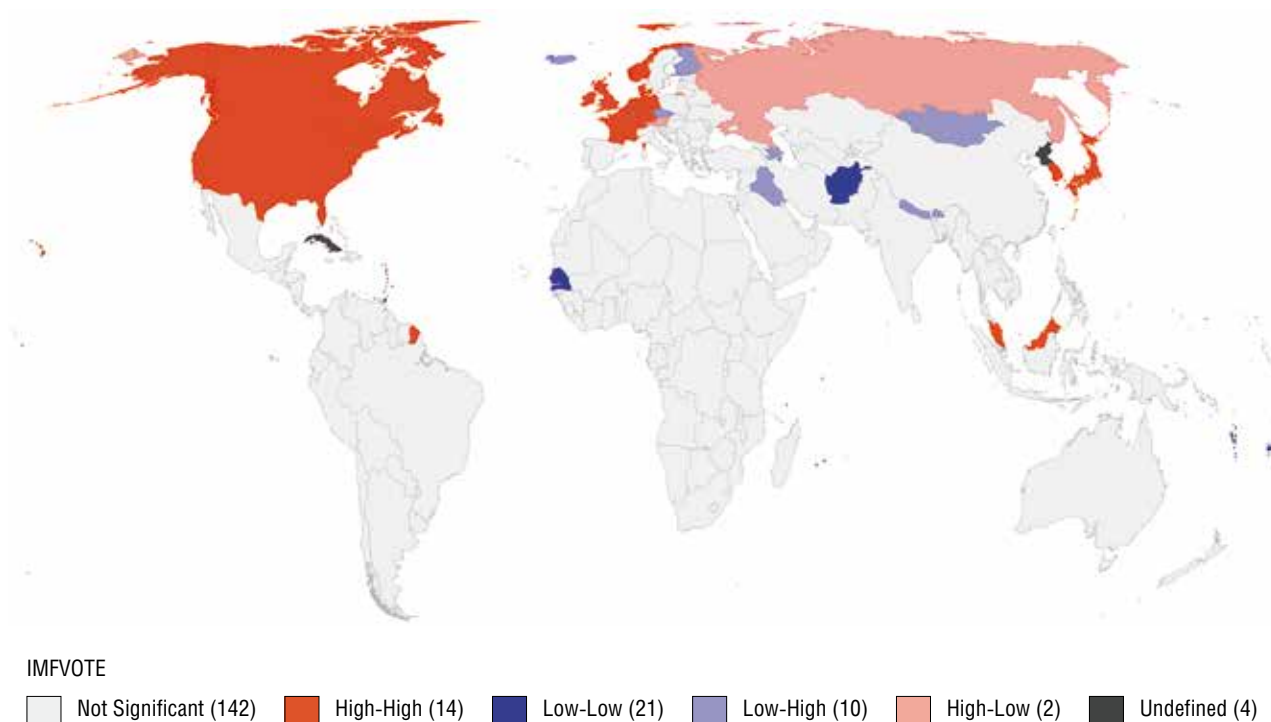


Fig. 5.6.3. “IMF voting power” spatial autocorrelation cartogram for the geometric neighbourhood matrix

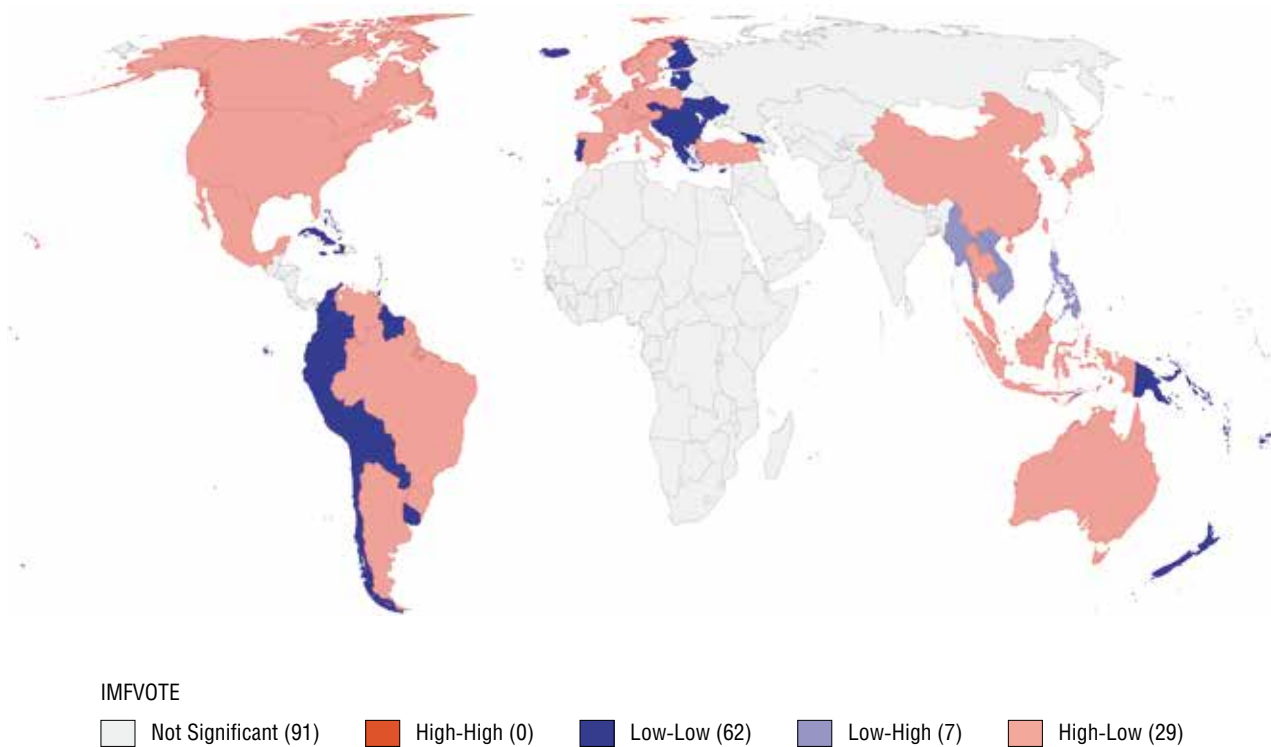


Fig. 5.6.4. “IMF voting power” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.7. Diplomatic missions

The number of diplomatic ties between states demonstrates their international activities, their ability to establish diplomatic relations in order to realize their foreign political goals, and their ability to use diplomatic relations to shape the international agenda and advance their interests through talks. Let us note that we only have indicator values for 60 states, which limits our analysis.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.342	0.000	0.226	0.000
Geary's C	0.823	0.001	0.770	0.000

The percentile cartogram (Fig. 5.7.1) shows that states of Northern Europe have the smallest numbers of diplomatic ties. This may be due to their remote geographic position. ASEAN states also have small numbers of diplomatic ties. States defined as mid-level powers can be said to have fewer diplomatic ties than larger states that position themselves as great powers.

In addition to China, the leader in this indicator, countries with the highest numbers of ties are Russia, the United States, Turkey, France and Japan, which attests to these states actively using diplomatic ties, among other means, to advance their agendas internationally, although each state has a different understanding of diplomacy and a different diplomatic style. The United States, for instance, interprets diplomacy broadly as a phenomenon that is generally identical to foreign policy. Diplomatic service is one of the many tools for advancing US foreign policy. China treats diplomacy as part of a society's political culture. France is considered to be a master of the diplomatic art, using diplomacy to increase its weight and influence internationally. Japan emphasizes the role that information and psychology play in diplomacy. Turkey is known for its skill in maneuvering between great powers and for pursuing a policy of balancing while at the same time practicing scepticism and caution. Russia strives for maximum integration into international cooperation bodies, basing its activities in them on the principles of equality and fully accounting for national specifics and interests.

Global place	Country	Indicator
1	China	276.00
2	US	273.00
3	France	267.00
Mean (26–27)	(Australia, Belgium)	120.21 (118.00)
Median (30; 31)	(Saudi Arabia; Malaysia)	110.50 (114.00; 107.00)
58	Luxembourg	37.00
59	Iceland	25.00
60	Bhutan	9.00

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Canada and Mexico stand out in the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.7.3), as they have large numbers of diplomatic ties with other countries, as do their neighbours, thus forming a high-high cluster. Another standout is China, which, compared to its neighbours, has a high number of diplomatic ties with other countries, making it a high-low cluster. Unlike China, Mongolia forms an opposite cluster and, despite being surrounded by countries with high numbers of diplomatic ties, cannot boast similarly high values. Finally, South Korea and North Korea constitute two opposites: South Korea has a large number of diplomatic ties, since it is tightly built into the international relations system, while the same cannot be said about North Korea due to it being a closed state.

The geopolitical neighbourhood matrix cartogram (Fig. 5.7.4) shows a far larger number of clusters. In this instance, the world may be divided into states that are actively involved in global politics and advance their agendas internationally, and those that are mostly focused on domestic matters or else only reluctantly open up to other states. Russia, Turkey, China, Japan, Saudi Arabia, Australia, New Zealand, South Africa, Brazil, Argentina, the countries of Western and Northern Europe and North America, and the ASEAN states are all active diplomatically. The countries of the Maghreb, Egypt, Somalia, Oman and Yemen are less active.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Diplomatic missions” parameter (Fig. 5.7.2) yields several clusters of states with similar characteristics. First, these are European states that, due to their open border policy, among other things, have many diplomatic ties and interactions. There are clusters of Eastern European states, Middle Eastern states, and also Central Asian states. Additionally, there are great similarities in West and Central Africa. Russia and China are parts of East Asian states cluster. Finally, there is a Caribbean cluster. This cartogram may be said to reveal regional clusters, which may be due to cultural and/or linguistic similarities of states in a particular region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Number of doctors	0.076	0.033	0.273	0.984
2	Rate of gross accumulation	0.074	0.037	-0.217	0.634
3	Passport power	0.070	0.042	0.193	0.535
4	Life expectancy	0.068	0.044	0.182	0.488
5	Voter turnout	0.084	0.030	-0.201	0.478
6	Urbanization	0.103	0.012	0.212	0.436
7	Sovereign debt	0.150	0.003	0.231	0.356
8	Elderly population	0.094	0.017	0.176	0.331
9	Maternal mortality	0.094	0.017	-0.174	0.321
10	Tertiary education enrolment	0.112	0.010	0.176	0.276

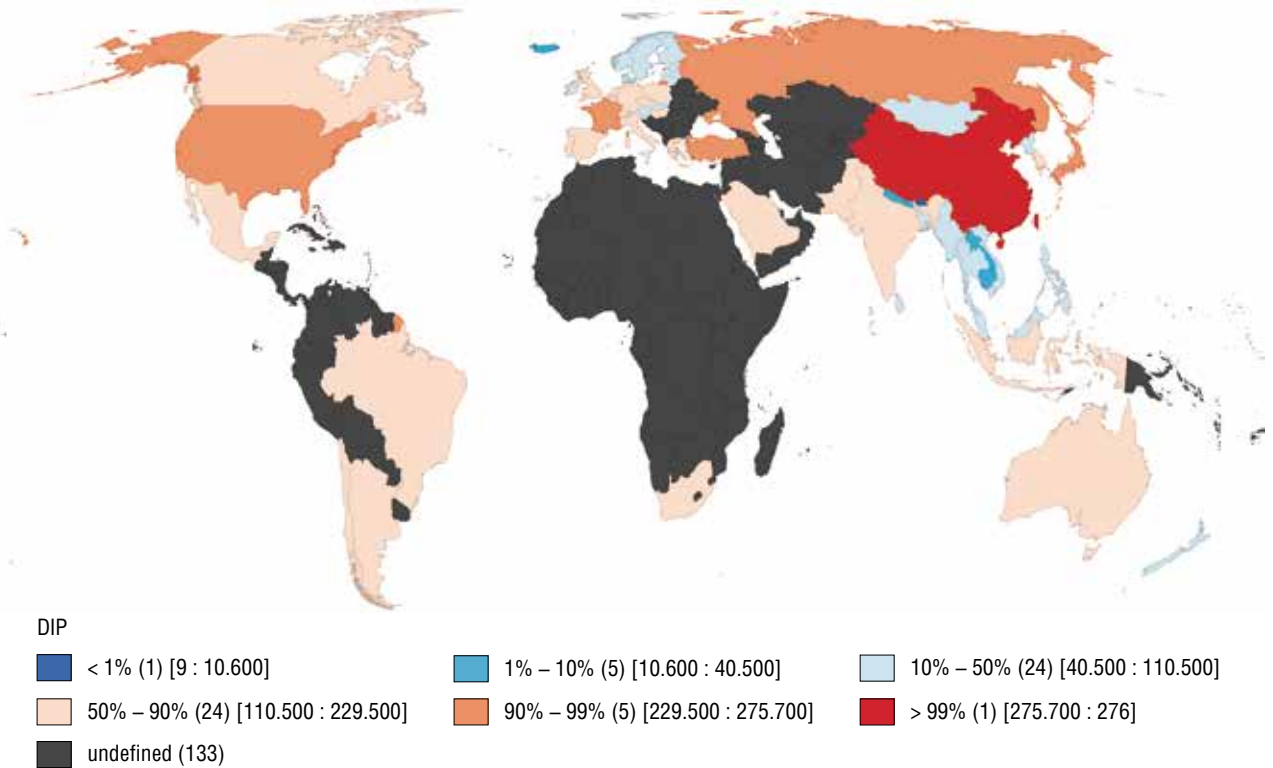


Fig. 5.7.1. Percentile cartogram for the “Diplomatic missions” indicator

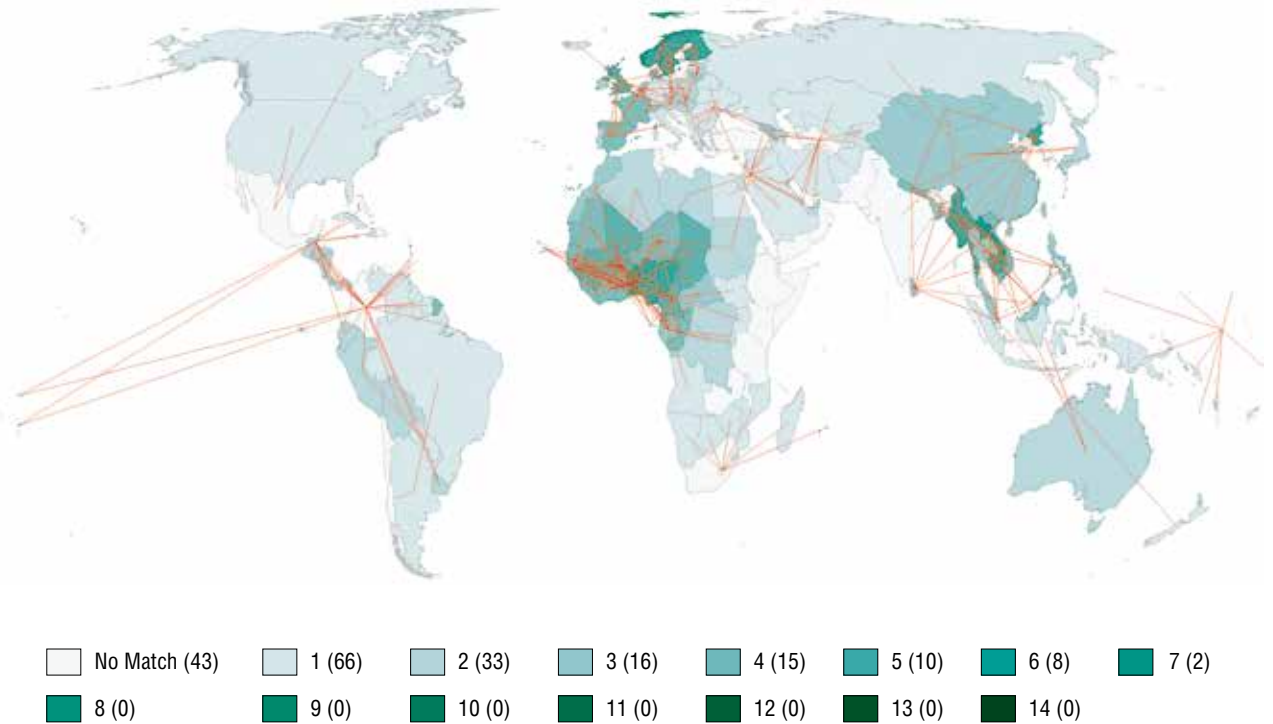


Fig. 5.7.2. Likelihood-ratio test for the “Diplomatic missions” parameter

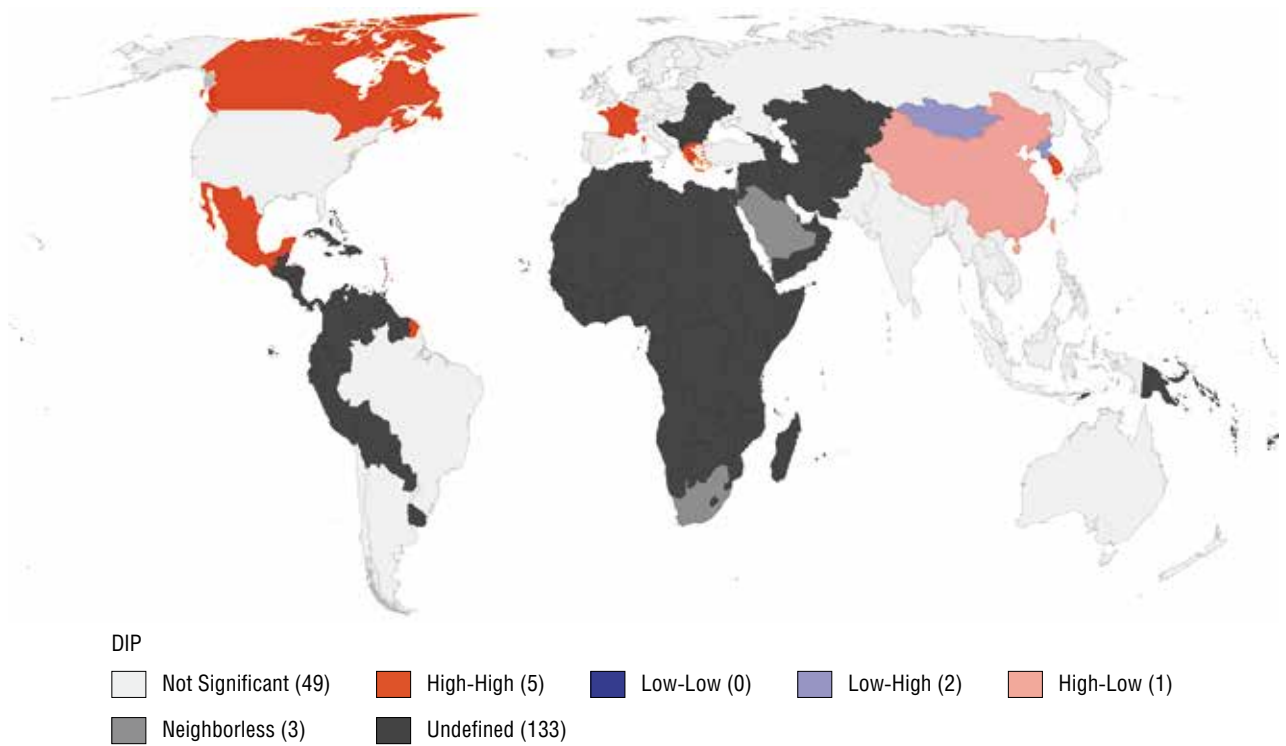


Fig. 5.7.3. “Diplomatic missions” spatial autocorrelation cartogram for the geometric neighbourhood matrix

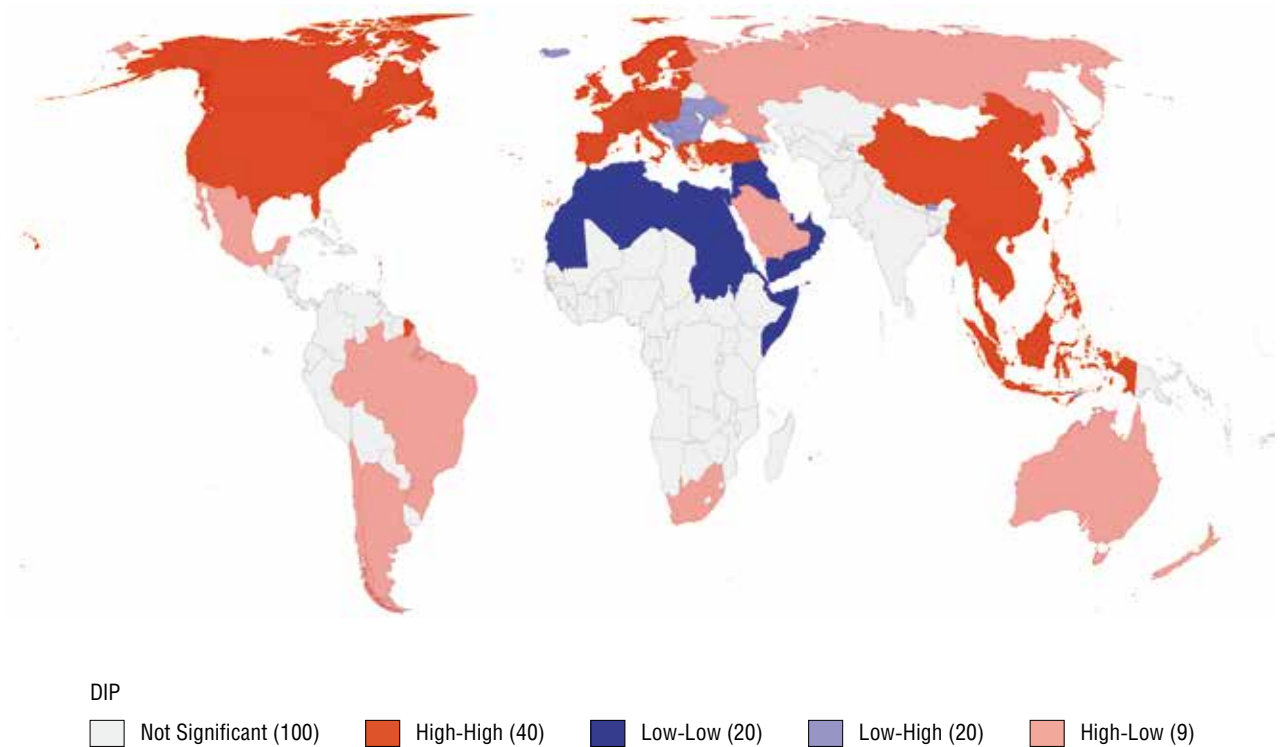


Fig. 5.7.4. “Diplomatic missions” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.8. Passport power

Passport power demonstrates a state's friendly relations with other states, allowing the mobility of its citizens.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.690	0.000	0.621	0.000
Geary's C	0.300	0.000	0.377	0.000

The percentile cartogram (Fig. 5.8.1) shows that the world is divided into North and South: countries of the North are more mobile, and passports of these countries allow their holders to visit larger numbers of states, while countries of the South are more closed, and their citizens face greater obstacles when traveling to other states. The United Arab Emirates is the country most open to visitors. After the Iran–Iraq war, which plunged the country into recession, the United Arab Emirates irrevocably “sided with the West” and proceeded to steer a course towards complete openness and integration into the global market. The country created a system that is conducive to labour migration yet protects its people from erosion and supplantation. Along with producing and exporting mineral resources, as well as its trade in goods and services, tourism makes a significant contribution to the country's economy. The United Arab Emirates is also attractive for tourists thanks to the almost non-existent terrorist threat, the low level of street crime, and the fact that the streets are patrolled by English-speaking police officers. Afghanistan's passport is the weakest since its citizens cannot move to another country, and also because there is a civil war that has been going on for decades.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.8.3) shows that the world once again may be divided into North and South. The countries of the North have high passport

Global place	Country	Indicator
1	United Arab Emirates	179.00
2–5	Germany, Spain, Luxembourg, Finland	172.00
6–16	Austria, Denmark, Ireland, Italy, Netherlands, Portugal, US, Switzerland, South Korea, Japan	171.00
Mean (92)	(South Africa)	107.16 (103.00)
Median (97)	Belize	97.00
191	Syria	40.00
192	Iraq	37.00
193	Afghanistan	35.00

power and high citizen mobility, with the exception of one state, Belarus, which, despite its neighbours, has a weak passport. Turkmenistan now forms part of a low-value cluster: the country itself and its neighbours have low passport power. Another cluster of countries with low passport power includes India, Pakistan and China. A large low-low cluster spans nearly half of Africa's states. This can be put down to the low level of tourism development in these countries, poor security, the high terrorist threat, and a large number of diseases in these countries.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 5.8.4) shows clusters that are somewhat changed compared to the previous cartogram, yet the overall trend of the North–South division remains. States with strong passports are collected in a high-high cluster including European states, the United States and Canada. There are two large low-low clusters. The first includes 20 African states (although this cluster has shifted westward compared to the previous cartogram), the second still includes India and Pakistan (compared to the previous cartogram), but now Afghanistan is part of the cluster, too. There is also a cluster of Arabian Peninsula states, although this does not include the abovementioned United Arab Emirates, which is not typical of its region.

Let us look at the results of a likelihood-ratio test for geometric and geopolitical neighbourhood for the “Passport power” parameter (Fig. 5.8.2). First, the countries of Europe and Canada form a cluster of states with similar parameters, and there is a cluster of Latin American states with roughly similar passport power values. Second, there are three clusters in Africa, namely, a cluster of West African states, cluster of the Horn of Africa states, and, finally, a cluster of Southeast African states.

There is no cluster of Southeast Asian states, and also no cluster of Eurasian states that would include Russia. In this case, we may be talking a high differentiation of states in these regions.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Women in politics	0.050	0.002	0.238	1.136
2	Linguistic diversity	0.191	0.000	-0.432	0.978
3	Economic inequality	0.065	0.001	-0.246	0.936
4	Population growth	0.280	0.000	-0.508	0.921
5	Ethnic fractionalization	0.108	0.000	-0.313	0.909
6	Cultural solidarity	0.121	0.000	0.331	0.904
7	Access to electricity	0.333	0.000	0.489	0.719
8	Highly wealthy population	0.106	0.000	-0.276	0.717
9	Maternal mortality	0.333	0.000	-0.475	0.677
10	Particulate air pollution	0.446	0.000	-0.549	0.676

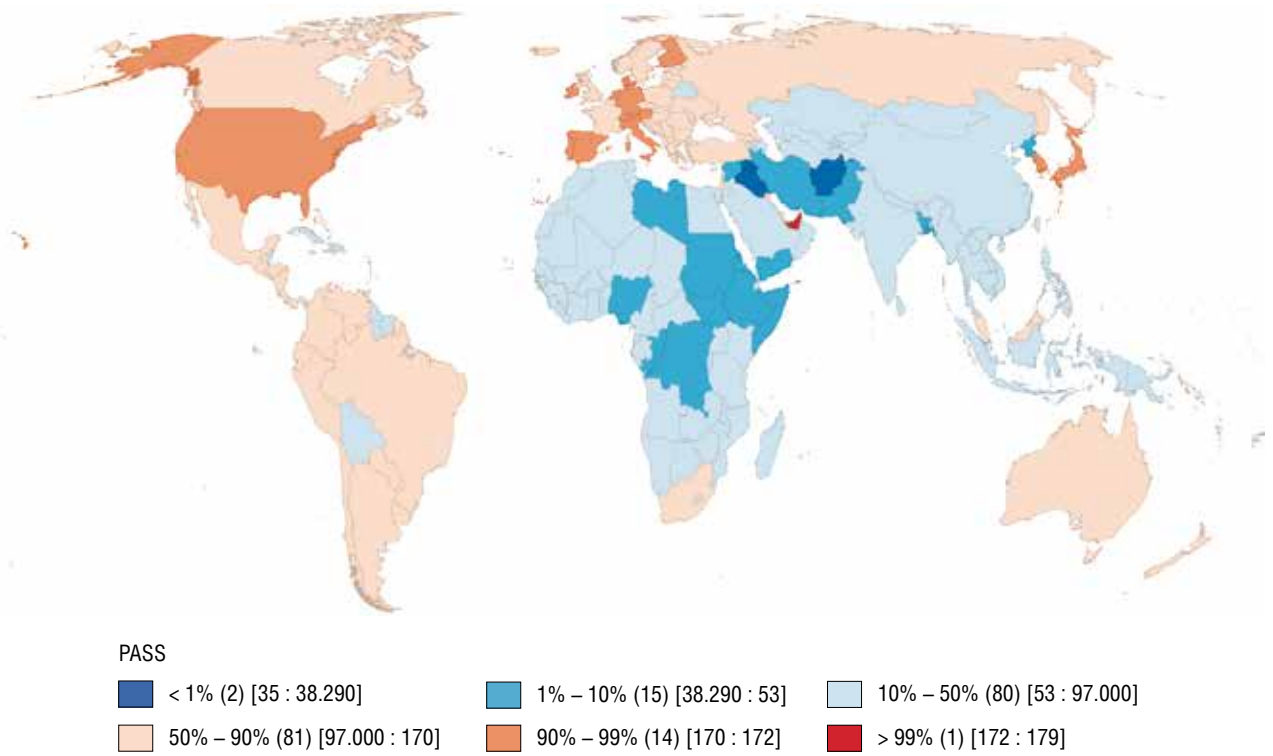


Fig. 5.8.1. Percentile cartogram for the “Passport power” indicator

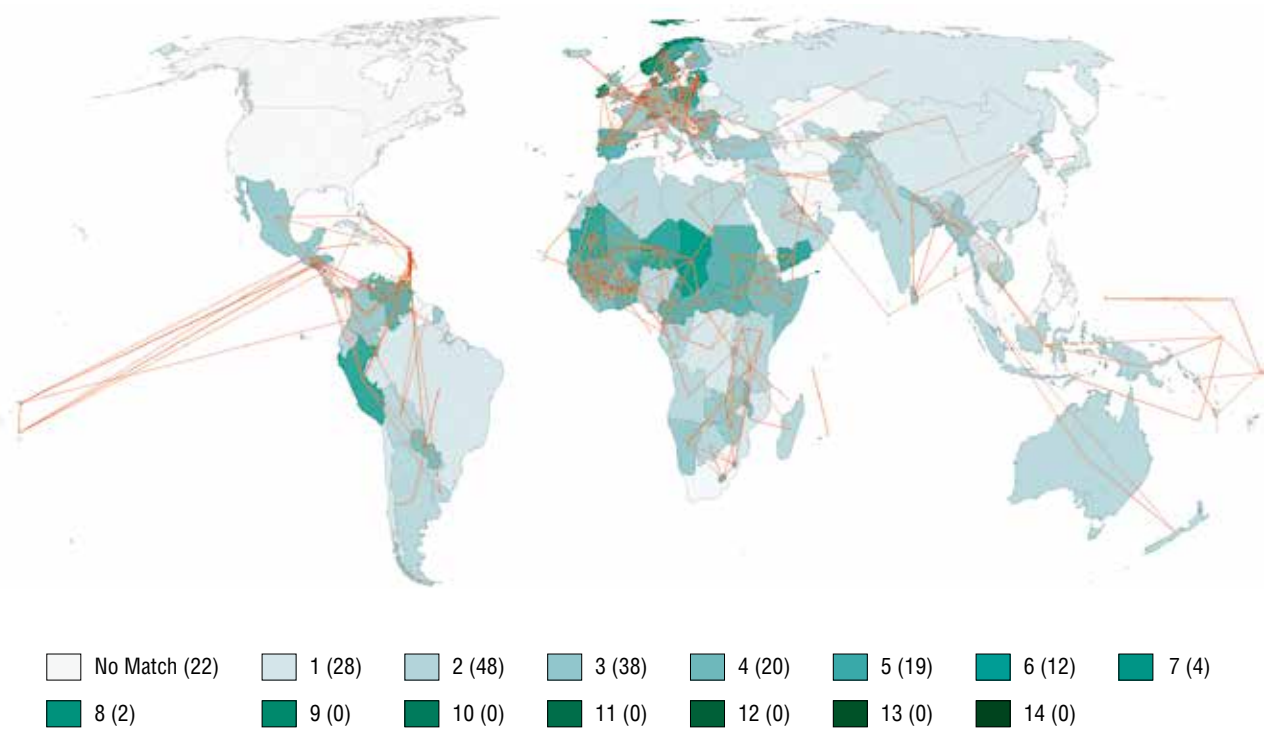


Fig. 5.8.2. Likelihood-ratio test for the “Passport power” parameter

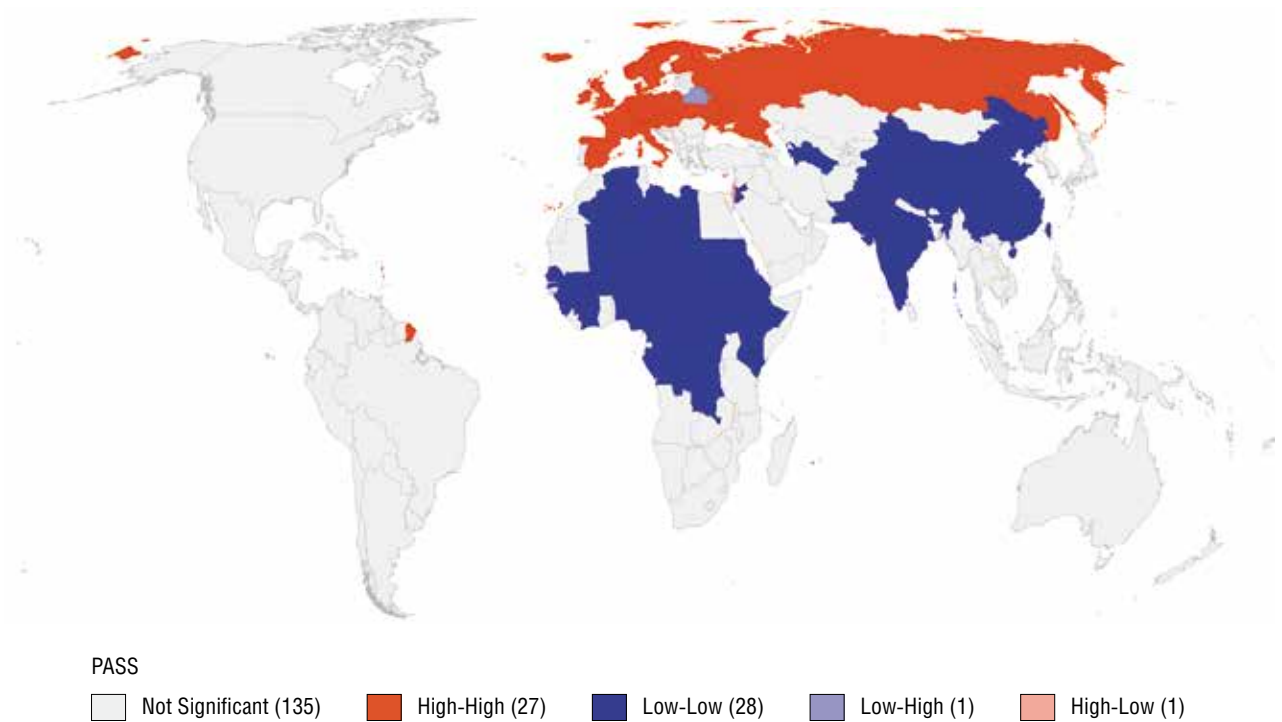


Fig. 5.8.3. “Passport power” spatial autocorrelation cartogram for the geometric neighbourhood matrix

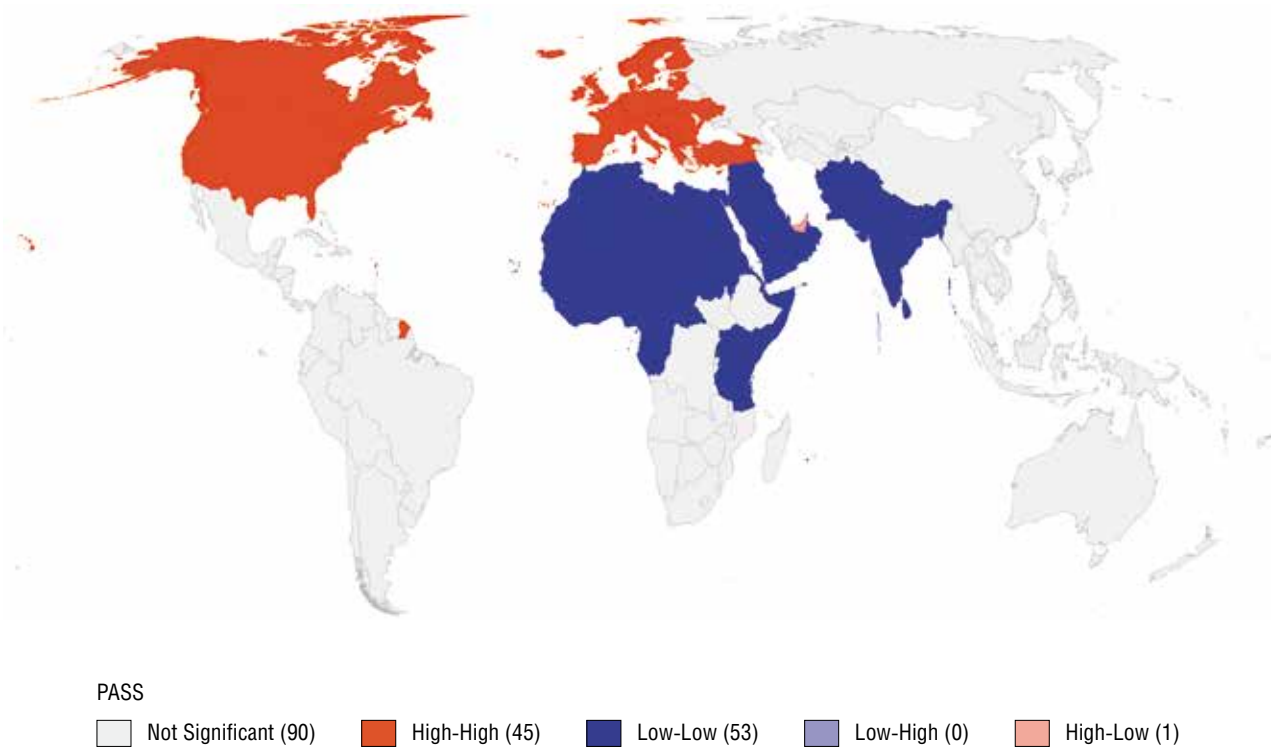


Fig. 5.8.4. “Passport power” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.9. Conflictogenity

Conflictogenity demonstrates, first, the situation in a state at a given time and, second, that state's involvement in ad hoc conflicts, which characterizes its involvement and influence in international affairs.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.530	0.000	0.393	0.000
Geary's C	0.488	0.000	0.604	0.000

The percentile cartogram (Fig. 5.9.1) shows a visible cluster of European states that are the most peaceful. Kazakhstan and Mongolia also stand out compared to their noticeably more conflictogenic neighbours. Additionally, Southeast Asia (with the exception of Thailand, which has experienced a series of military coups) may be called a relatively calm region.

In additions to the most conflictogenic countries of Africa with their ongoing civil wars, Russia and Ukraine also count as conflictogenic states due to the ceasefire violations in the Donbas that entail increased military presence of both states along the Russian–Ukrainian border, as well as primarily owing to the special military operation.

One country that stands out in Latin America is Venezuela, which has been dogged by a political crisis since 2019. High conflictogenity level is also typical for Syria (one of the most conflictogenic countries) and its neighbours, Turkey and Iraq, owing, first, to the Syrian conflict and, second, to Turkey's military operations in the north of Iraq against the Kurdistan Workers' Party.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.9.3) shows a cluster of low-low value states that are peaceful like their neighbours: these are the states of Western and Northern Europe. A standout exception here is Ukraine and Russia, which should have been as peaceful as its European neighbours, but, due to the special military operation didn't get into the mentioned European cluster.

Global place	Country	Indicator
1	Afghanistan	3.644
2	Syria	3.539
3	Iraq	3.487
Mean (70)	(Kyrgyzstan)	2.100 (2.094)
Median (83)	Bosnia and Herzegovina, Guyana	2.0495
158	Portugal	1.247
159	New Zealand	1.198
160	Iceland	1.078

A high-high cluster on the cartogram includes Iran, Azerbaijan, Iraq and Syria. This cluster stems from the ongoing Syrian conflict that in one way or other involves neighbouring states. Another high-high cluster includes countries of Central and East Africa, where civil wars continue to this day. Jordan is an exception from these two clusters as, despite its contradictions with Israel, is a relatively peaceful state due to the 1994 Israel–Jordan peace treaty. Two more exceptions on the cartogram are Mongolia and Japan (let us not forget that after its defeat in World War II, Japan only has self-defence forces, which are severely constrained by Article 9 of its Constitution; in addition, the 1947 Constitution of Japan legally enshrined the country's refusal to become involved in military conflicts, a provision that was amended in September 2015, when the Japanese parliament allowed the Self-Defense Forces to become involved in conflicts abroad. Currently, Japan is debating holding a universal referendum that will decide the fate of Article 9 of the Constitution).

The geopolitical neighbourhood matrix cartogram (Fig. 5.9.4) once again shows a cluster of peaceful European states. However, unlike on the previous cartogram, it now includes Eastern European countries. Ukraine is an exception here again. However, two more exceptions are added here whose conflictogenity is higher than that of their neighbours, namely, Georgia and Turkey. In this case, it is no coincidence that Turkey appears as an exception given its involvement in the conflicts in Syria and Nagorno-Karabakh.

Unlike the previous cartogram, this one shifted the cluster of highly conflictogenic African states northward. An exception from this cluster is Morocco, which, amid other states, appears relatively peaceful and where the neighbourhood effect does not ring true. If we ignore the conflict in the Western Sahara, we can see that Morocco is conflict-free. Let us also note that Morocco is a traditional regional ally of the United States and France, and in 2004 it was designated the main non-NATO ally of the United States. The Congo and Gabon are also “hot” areas in Africa since, in the case of the Congo, the conflict between the Hutus and Tutsis is still going on in Kivu, and, in the case of Gabon, there was an attempted coup in the country in 2019. Compared to these states, Equatorial Guinea moved to the cluster of relatively non-conflictogenic states, even though the country is not free of conflict: in 2019, the Cameroonian government accused Equatorial Guinea of violating its territorial integrity, and consequently, the latter erected watchtowers on its border with Cameroon.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Ethnic minorities	0.036	0.017	0.217	1.326
2	Population growth	0.055	0.003	0.262	1.241
3	Ethnic fractionalization	0.031	0.031	0.177	1.016
4	Royalties to foreign copyright holders	0.038	0.027	-0.176	0.814
5	Refugees	0.064	0.002	0.223	0.772
6	Depletion of natural resources	0.027	0.047	0.141	0.748
7	Linguistic diversity	0.057	0.002	0.204	0.725
8	Suicide rate	0.087	0.000	-0.252	0.716
9	Hospital beds	0.1248	0.001	-0.292	0.687
10	Number of doctors	0.137	0.000	-0.299	0.652

This cartogram features a Middle Eastern cluster that includes Saudi Arabia and Yemen. A civil war has been raging in Yemen since 2014, which cannot but affect Saudi Arabia, where the conflict continues in Najran, Jizan and Asir because a Saudi Arabia-led coalition invaded Yemen. Against this backdrop, Oman constitutes a relatively more peaceful exception here, having refused to join the Saudi Arabia-led anti-Yemen coalition in 2015. The country has remained neutral since 2017. For instance, it did not sever diplomatic ties with Qatar and helped it overcome the economic blockade imposed by Arab states over the emirate's support of terrorism and extremist ideology.

Compared to the relatively peaceful Canada, which is part of a low-low cluster, the United States stands out as a more conflictogenic country (high-low cluster). Papua New Guinea is the last difference from the previous cartogram, forming a high-low cluster: despite its fairly non-conflictogenic surroundings, the state itself may be potentially conflictogenic due to its confrontation with Indonesia. The population of Papua New Guinea is unhappy with the number of Indonesians moving to their country over the last few years in search of work while displaying a rather negative attitude to the local population.

A Likelihood-ratio test for the "Conflictogenicity" parameter (Fig. 5.9.2) yields clusters of similar states, and one such cluster includes the states of Western Europe and Canada. A more conflictogenic cluster includes the United States and Latin American clusters. Additionally, there are similarities between North African states, and Southern African states also form a separate cluster. The Middle East exhibits a greater differentiation among states, while Southeast Asia manifests a weak cluster, which also attests to greater differentiation between the region's countries.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

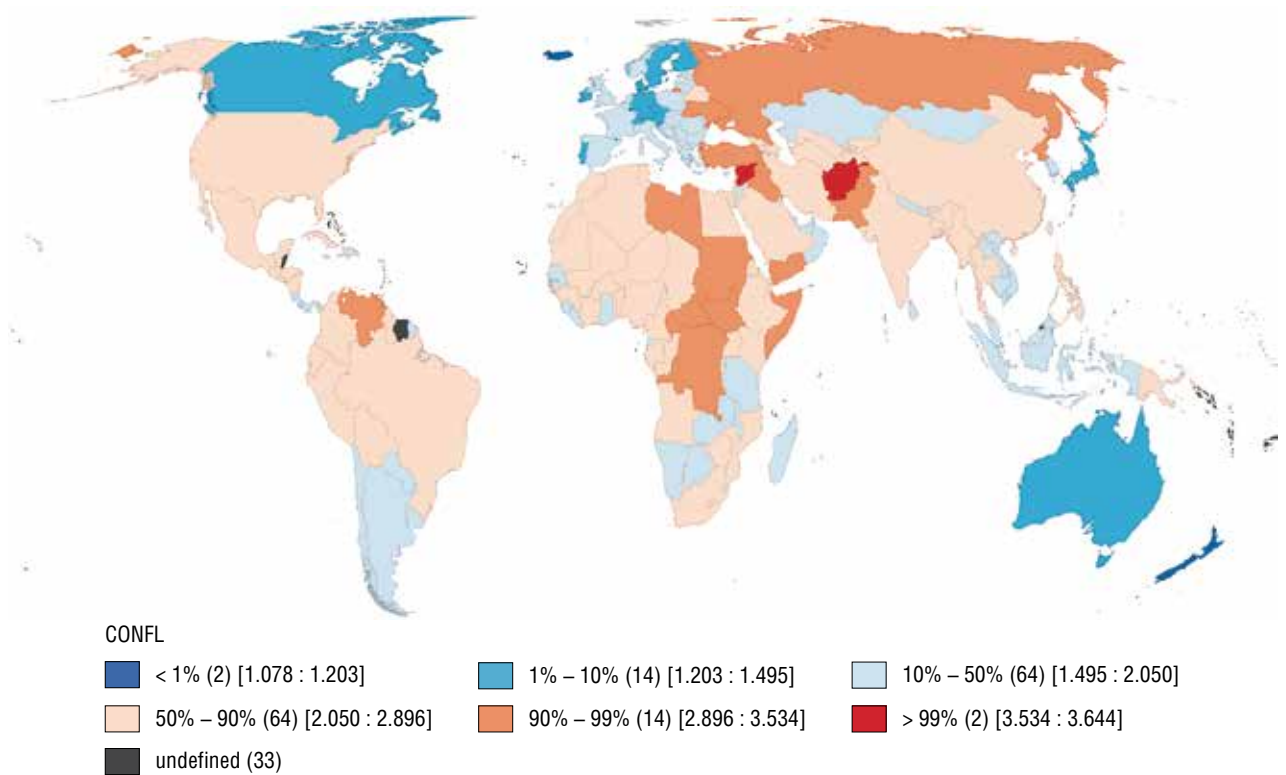


Fig. 5.9.1. Percentile cartogram for the “Conflictogenity” indicator

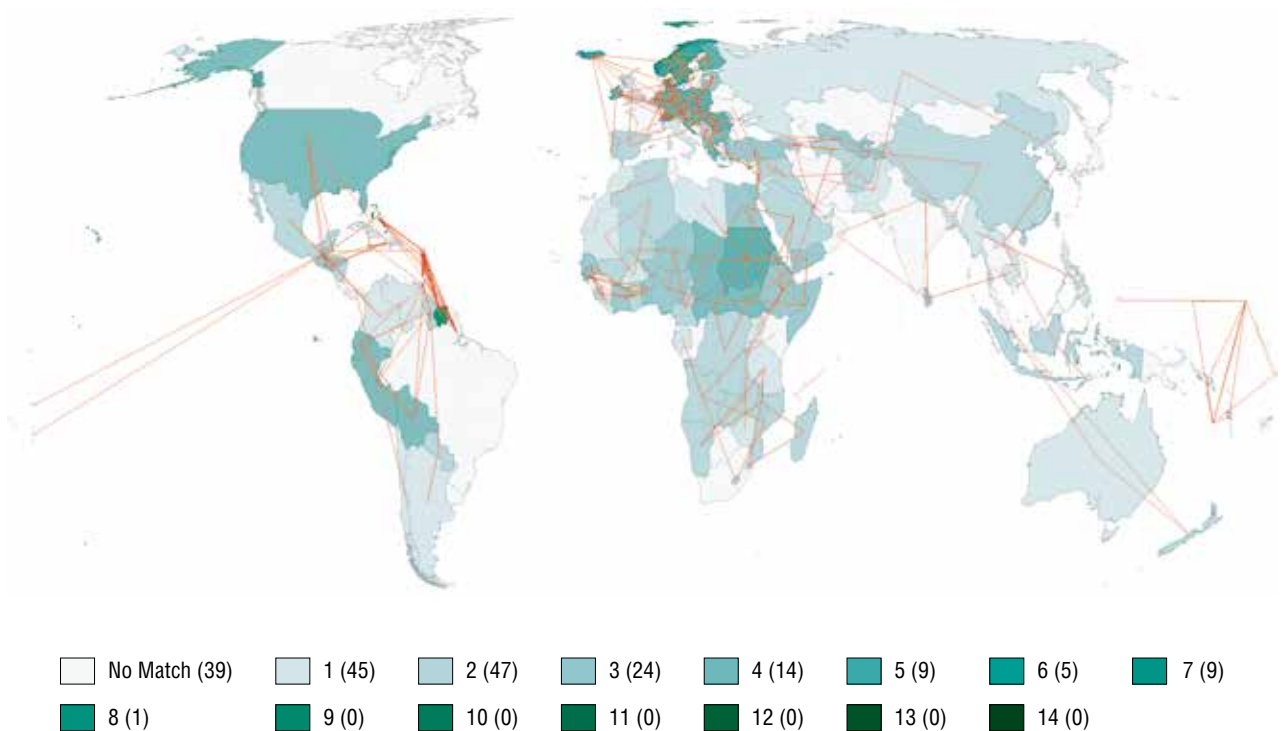


Fig. 5.9.2. Likelihood-ratio test for the “Conflictogenity” parameter

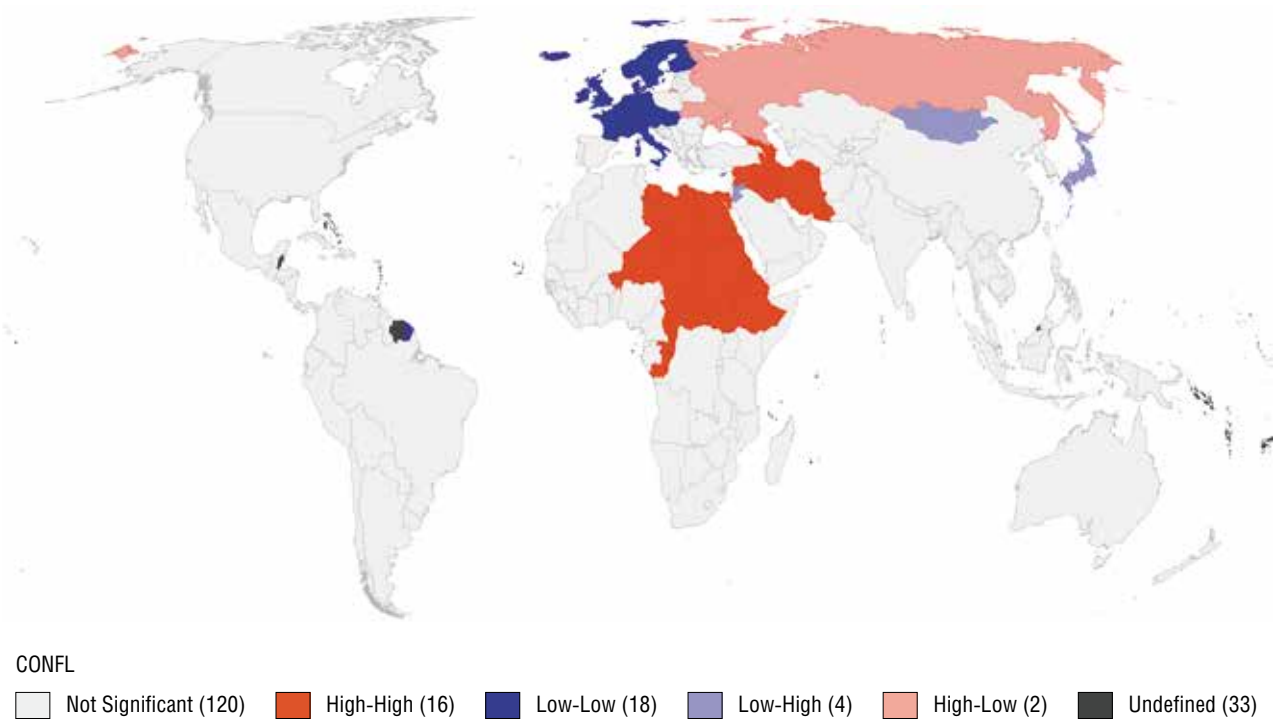


Fig. 5.9.3. “Conflictogenity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

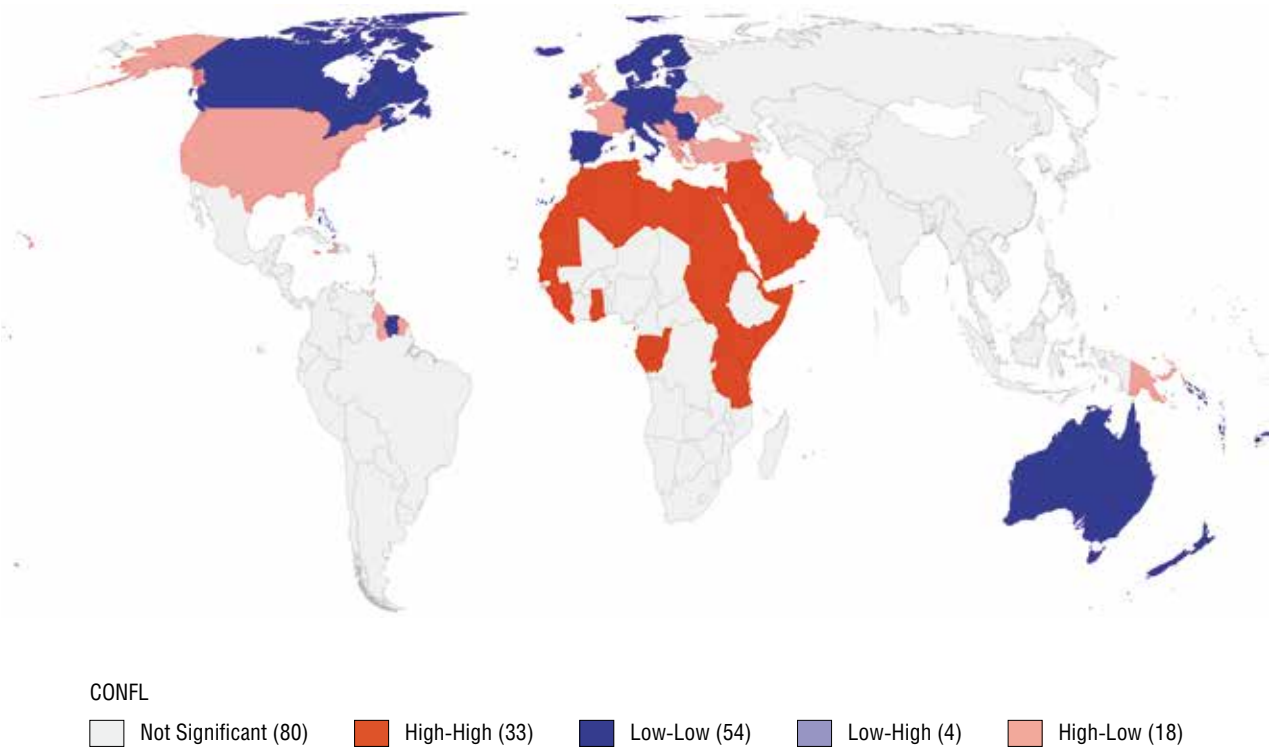


Fig. 5.9.4. “Conflictogenity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.10. Military expenditure

Military spending shows how much a state is willing to allocate to its military needs, demonstrates the degree of its militarization, and reveals the degree to which the military is prioritized compared, for instance, to spending on education, healthcare, etc.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.293	0.000	0.234	0.000
Geary's C	0.821	0.019	0.762	0.000

The percentile cartogram (Fig. 5.10.1) shows that more than half of all countries have high military spending. The two leaders are Libya (which has been ravaged by a military conflict for the last ten years involving every possible group, from fundamentalist fanatics to private military companies and foreign armed forces) and Oman (despite its high inner stability, it is surrounded by conflicts, such as the war in the Persian Gulf, the Iran–Iraq war and the war in Yemen, and such surroundings necessitate major military spending to ensure its security). Other standouts include: Oman's neighbours, Yemen and Saudi Arabia; Algeria, which neighbours Libya; Pakistan, which is located next to the troubled Afghanistan to the north, and India, which is involved in conflicts over Kashmir, to the south. Additionally, high military spending is demonstrated by Armenia and Azerbaijan, which are locked in a conflict over Nagorno-Karabakh. Finally, Russia also has high military spending.

Lesser military spending is demonstrated by countries of Southeast Asia, and also by Mexico and Venezuela. Notably, low military spending is exhibited, for instance, by Germany, Italy and Japan, which largely count on US protection. Washington has called these countries out over this policy, with Germany taking the brunt of the criticism, being told it should increase its military spending to 2% of its GDP.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 5.10.3) reveals a cluster of Middle Eastern states with high military spending both within the states themselves and in their

Global place	Country	Indicator
1	Libya	15.50
2	Oman	8.80
3	Saudi Arabia	8.00
Mean (53–57)	Australia, China, Portugal, France, Sri Lanka	1.93 (1.90)
Median (76–82)	Brazil, Kyrgyzstan, Lesotho, New Zealand, Senegal, Finland, Central African Republic	1.50
151	Ireland	0.30
152	Mauritania	0.20
153–156	Haiti, Iceland, Costa Rica, Panama	0.00

neighbours, which is understandable given the number of conflicts in this region, ranging from the conflict in Yemen and the states that are involved in it, to the Syrian conflict and the Arab–Israel conflict. In addition to conflicts and wars, which demand military spending, these countries also import weapons, and weapons manufacturing also qualifies as military spending. The world’s largest weapons deals are also concluded in the Middle East. Egypt is an exception here, as its military spending is lower than that of its neighbours, although the country was the world’s third-largest weapons importer in 2015–2019. This difference is explained by Egypt’s mounting foreign debt, which restricts its spending. Another country on this cartogram that deserves a special mention is the United Kingdom, which was included in a cluster of states with low scores for both the state itself and its neighbours.

The geopolitical neighbourhood matrix cartogram (Fig. 5.10.4) shows changes to clusters. The Middle Eastern cluster shrank to include only the states of the Arabian Peninsula. Compared to their neighbouring African states, Egypt and Sudan demonstrate relatively low military spending. Last year, education spending exceeded military spending in Sudan for the first time in the country’s history.

Africa also contains a cluster of states with high military spending, namely Libya, Algeria, Morocco and Mauritania. This is due to the fact that they neighbour Libya, which suffered through a civil war in 2014–2020. Neighbouring on these states is a small cluster formed by two states, Senegal and Guinea Bissau, where military spending is lower than that of their neighbours, which may be explained by their size. The cluster of high-low exceptions includes Mali, Burkina Faso and Guinea, which may be because of the instability in each of these states and the military confrontation between the official authorities of these states and Salafi terrorist groups, essentially continuing the civil war in Algeria that was suspended in 2002.

Another cluster includes Angola and Zambia, where military spending is low within the countries themselves, and amongst their neighbours. On the contrary, neighbouring Namibia and Botswana spend large amounts on military purposes compared to surrounding countries.

Predictably, a likelihood-ratio test for geometric and geopolitical neighbourhood for the “Military spending” parameter (Fig. 5.10.2) clearly identifies Middle Eastern states with high military spending. Additionally, similarities are exhibited by countries in Europe, West and Southern Africa, the Caribbean and Southeast Asia. The differentiation of states is visible where no nodes emerged: these are the United States and its immediate neighbours, and Russia and its immediate neighbours.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Particulate air pollution	0.040	0.013	0.254	1.593
2	Female labour	0.106	0.000	–0.338	1.079
3	Suicide rate	0.030	0.040	–0.162	0.876
4	Alcohol consumption	0.067	0.001	–0.234	0.815
5	Forest areas	0.113	0.000	–0.299	0.790
6	Female population	0.151	0.000	–0.309	0.633
7	Women in politics	0.041	0.012	–0.16	0.629
8	Unemployment	0.102	0.000	0.251	0.617
9	Institutional foundations of democracy	0.121	0.000	–0.246	0.501
10	Renewable energy	0.095	0.000	–0.21	0.463

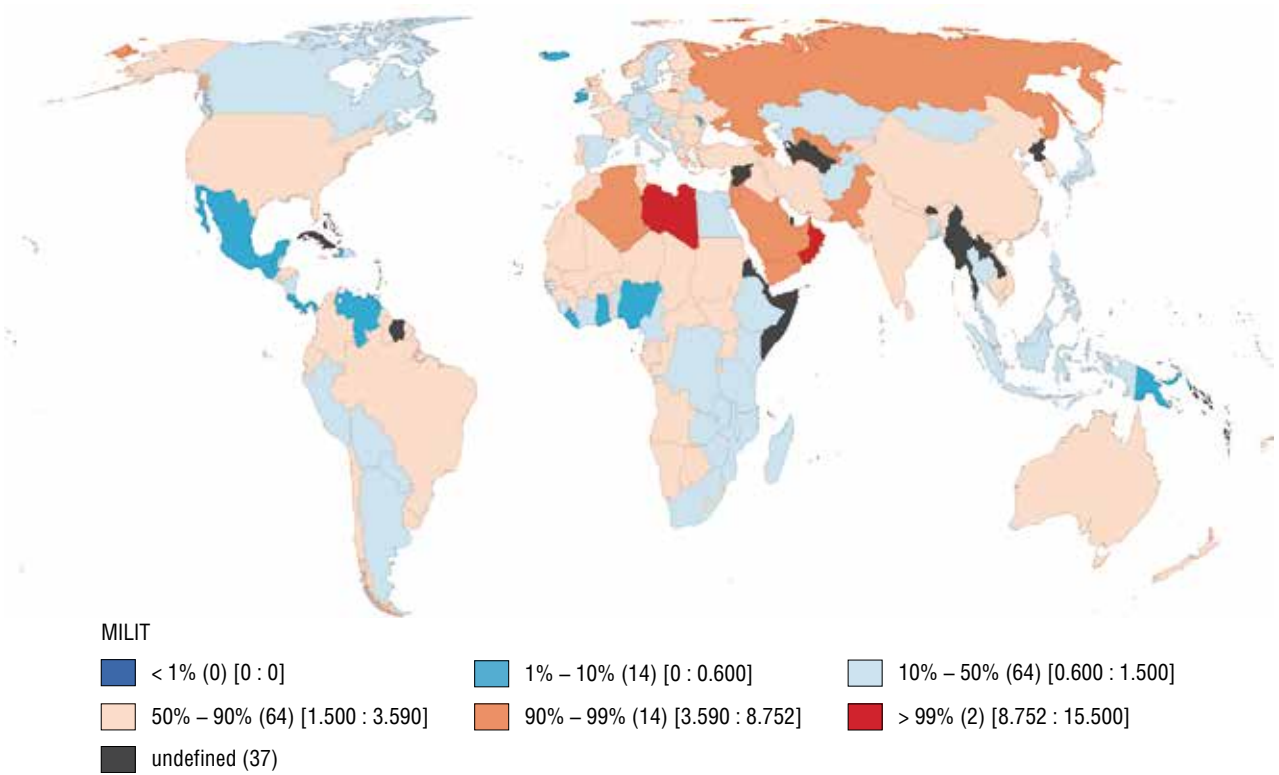


Fig. 5.10.1. Percentile cartogram for the “Military spending” indicator

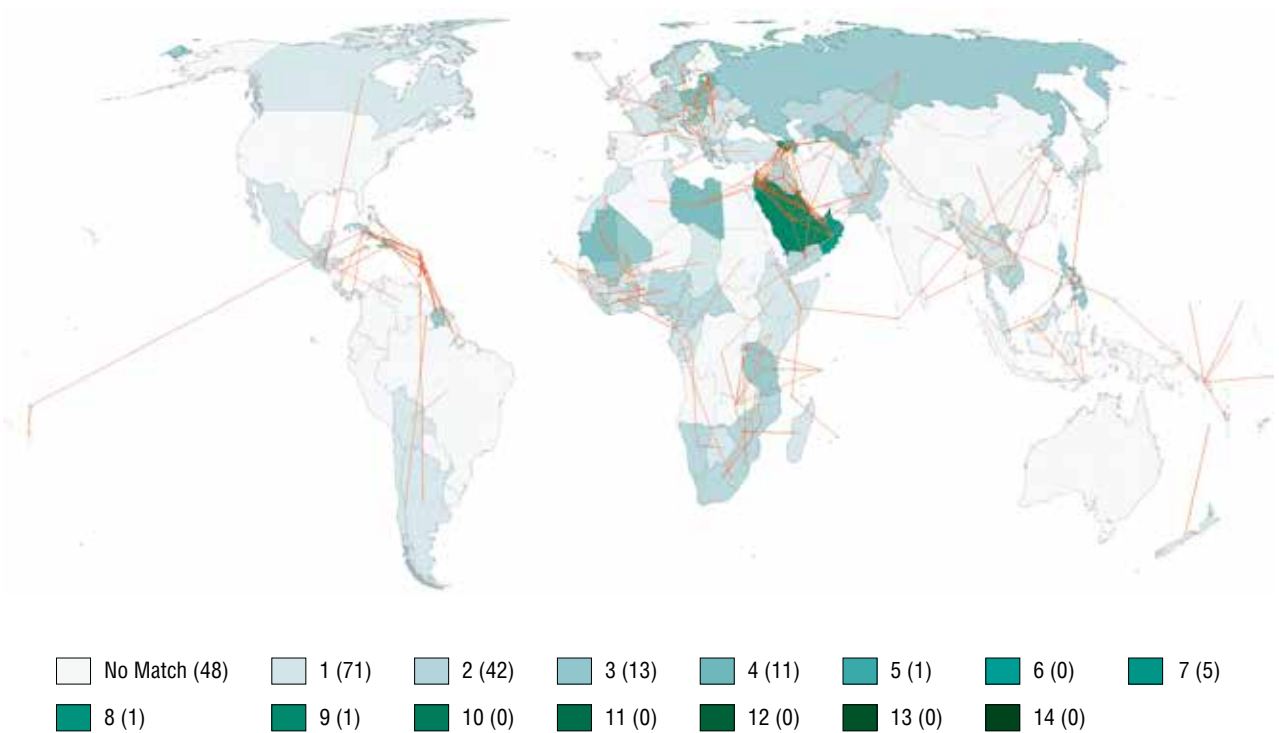


Fig. 5.10.2. Likelihood-ratio test for the “Military spending” parameter

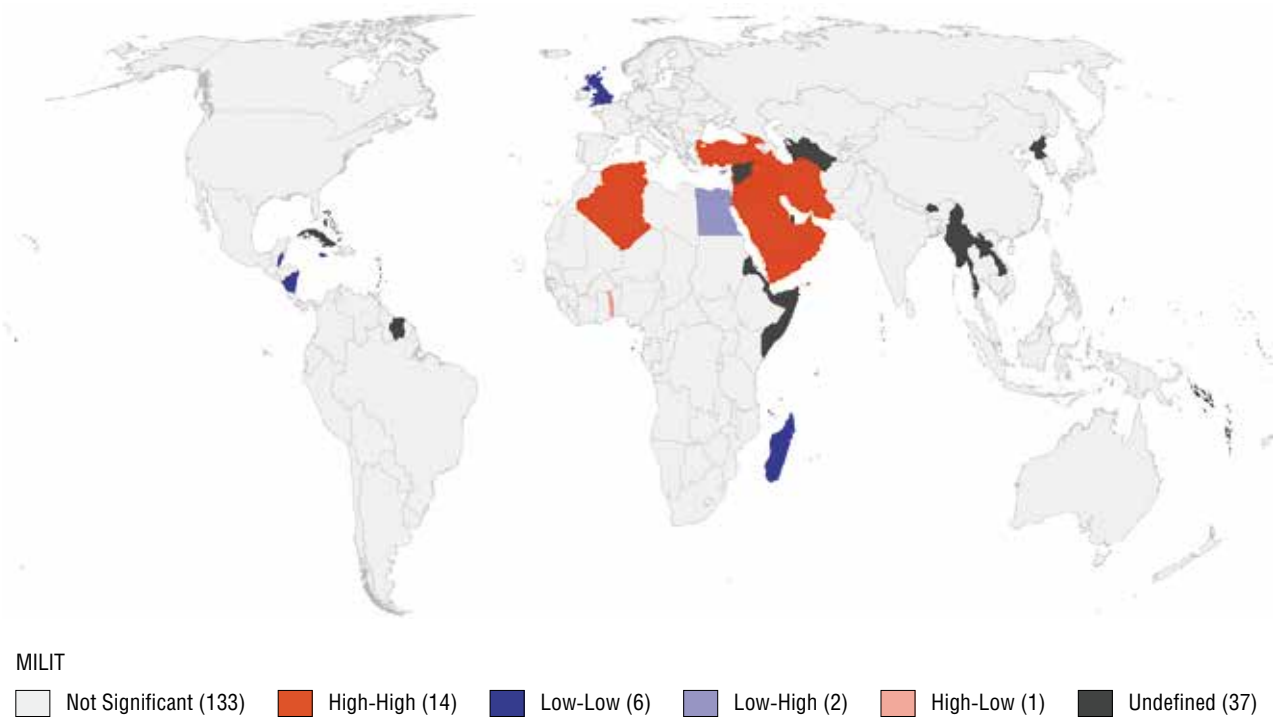


Fig. 5.10.3. “Military spending” spatial autocorrelation cartogram for the geometric neighbourhood matrix

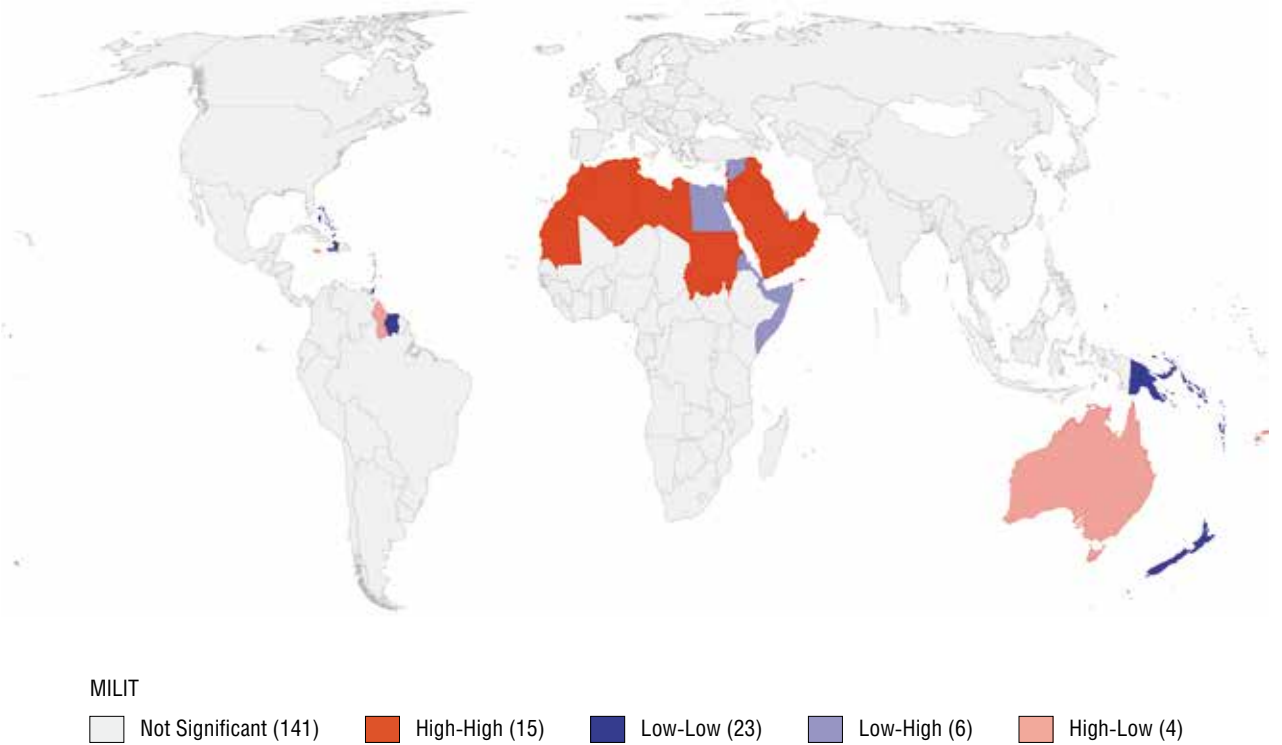


Fig. 5.10.4. “Military spending” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

5.11. Multifactor analysis of the “Politics” section indicators

The “Politics” section indicators demonstrate major divergences between geographic average ellipses for such indicators as “Military expenditure”, “Public organizations” and “Women in politics”.

The ellipse for the “Public organizations” indicator demonstrates the highest divergence: its geographic average demonstrates a major north-western shift compared to other two points, while the ellipse is significantly stretched towards the United States. Indeed, the United States is the indisputable leader in the number of non-governmental organizations (NGOs), far exceeding other countries. Additionally, there are far more NGOs in European states compared to other countries, which reflects a high level of civil society development and the spread of the “soft power” concept.

As for the “Military expenditure” and “Women in politics” indicators, these ellipses are far closer to each other, even though the former is somewhat shifted eastward compared to the latter. Indeed, military spending in Asian countries is high enough, while percentages of female MPs are far below those in European states and in both Americas.

Latin American states and countries of the Caribbean stand out when we consider geographic average ellipses by geopolitical group. The ellipses of these countries for Conflictogenity and IMF voting power are roughly similar both in shape and size. The United States is the leader in the geopolitical cluster of Western countries in terms of IMF voting power, which deforms the ellipse and connects the continents. The conflictogenity ellipse will be stretched towards Russia because of the special military operation in Ukraine. In the geopolitical cluster of Russia and Central Asia states, the IMF quotas ellipse will be stretched towards Russia because its voting power is greater than that of its neighbours, while the conflictogenity ellipse will be shifted towards Central Asia due to the conflict between Kyrgyzstan and Tajikistan over unresolved territorial disputes and the water issue. The geopolitical cluster of Middle Eastern states has a rather narrow ellipse for the IMF voting power, and is deformed by Saudi Arabia’s indicators. The conflictogenity ellipse is far wider due to the large number of conflicts in such a small territory. India stands out in South Asia due to its IMF voting power, while the level of conflictogenity unites all the countries in the region due to the India–Pakistan conflict and the instability in Afghanistan. In the African geopolitical clusters, the ellipses for IMF voting power and conflictogenity virtually coincide due to the small contributions the countries make to the IMF and large numbers of contradictions within each cluster. In Southeast Asia, the IMF voting power ellipse is skewed towards China and Japan, while the conflictogenity ellipse unites ASEAN countries and China, which might be partially due to the conflict in the South China Sea. Finally, the ellipses in Australia and Oceania have different shapes: the conflictogenity ellipse is stretched towards Papua New Guinea due to the conflict there and Indonesia’s involvement in it.

The geometric neighbourhood matrix (Fig. 5.11.1) shows two clusters of countries that are most similar to their neighbours in eight indicators of the “Politics” section. The first cluster includes virtually all EU countries and the United Kingdom. Here, once again, these neighbouring countries score similarly for virtually all indicators of the “Politics” section, with the exception of two indicators where data was not available for every country (number of diplomatic missions and passport power index). This cluster has relatively homogeneous high indicator values. The second cluster includes virtually all the countries of West Africa and some Central African states.

The geopolitical matrix (Fig. 5.11.2) demonstrates several differences. The United States and Canada are added to the European cluster. The cluster itself retains only the key, weighty EU states, the ones that stood at the origins of the European Union and signed the Treaty of Rome: France, Germany, Belgium, the Netherlands and Luxembourg. The United Kingdom also made the cluster and, while it is no longer an EU member, it plays an important role in both global and European politics. Additionally, there is also a Fennoscandia cluster. We may say, therefore, that here is the outline of the Euro-Atlantic system that brings together states similar in the eight political indicators under consideration.

The cluster analysis cartogram non-adjusted for geographic proximity (Fig. 5.11.3) shows the following clusters. First, there is a cluster that includes European countries and the United States, as well as Japan, which, among other things, identifies itself with the leading European states and is a G7 member. The second cluster includes the countries of Fennoscandia, as well as Canada and Australia, which can also be included in the European cluster, but have somewhat lower values for some indicators than the countries of the first group. Then there is a cluster of Southeast Asian states with high regional standing. These are India, China. Brazil and Turkey are added to the same cluster based on the values of all the ten indicators. There are also three large clusters in Africa: a cluster of countries in Southern Africa, a West African cluster and a cluster that includes Central African states and the former British colonies in North Africa. Let us also note that even statistically, these countries have similar characteristics.

The second cartogram (Fig. 5.11.4), where the geographic factor is assigned the same weight as the sum total of other indicators, shows far sharper clusters. Few countries stand out here: Turkey stands out against the cluster of Mediterranean and Eastern European states, which separates it from those states in several indicators and puts it closer to such large states as Russia, China and India.

Tunisia stands out among the African clusters as a state whose indicator scores are closer to those of Eastern European countries. This may be because Tunisia, unlike other countries that experienced the Arab Spring, has succeeded in avoiding domestic conflicts and coups and implemented successful democratic reforms. Unlike on the map of geographic clusters, political indicators brought together virtually all the countries of North Africa, the Middle East and West Asia, where Islam is widespread. As for Latin American countries, Suriname stands out from the cluster — as the smallest country in Latin America, it demonstrates greater similarity to small island states such as the Bahamas and Antigua and Barbuda. Additionally, Suriname was a Dutch colony, unlike most Latin American countries, which were under either Spanish or Portuguese rule, and, consequently, it is different from other Latin American states both culturally and linguistically (it is the only state in the region with a Germanic language).

A comparison of the two cartograms shows that the second has sharper cluster outlines and far fewer exceptions. However, both cartograms feature the same exceptions: Suriname (as mentioned above), South Korea and Nepal, which, sandwiched between two large neighbours, China and India, balances between the two and is highly unlike either. Let us also note that these differences also have historical roots, when Nepal adhered to isolationist policies during the times of the British Raj.

The scatter plot (Fig. 5.11.5) showing the results of multidimensional indicator scaling of country indicators features three best-defined clusters. The first cluster (1) includes all small island states that, because of their geographic features and history, have similar indicators. The second conglomerate of states (2) includes countries of East Africa with similar parameters. The third group of states (3) includes Central African countries and those North African states that are former British colonies.

Let us also note clear “outliers” whose parameters set them apart from the overall mass of countries situated mostly in the top part of the dispersion chart. The strong states of Europe, such as the United Kingdom, France, Germany and Japan (let us note parenthetically that some researchers classify Japan as part of the West) are located in the bottom left quadrant further away from the axis. The bottom right quadrant features such outliers as Saudi Arabia, Libya and South Sudan. Russia, India and China, three major states in both size and international weight, are located closer to the axis in the bottom left quadrant. We can state that political indicators in some way or other bring countries together into certain clusters and identify those that occupy a special position in the modern system of international relations.

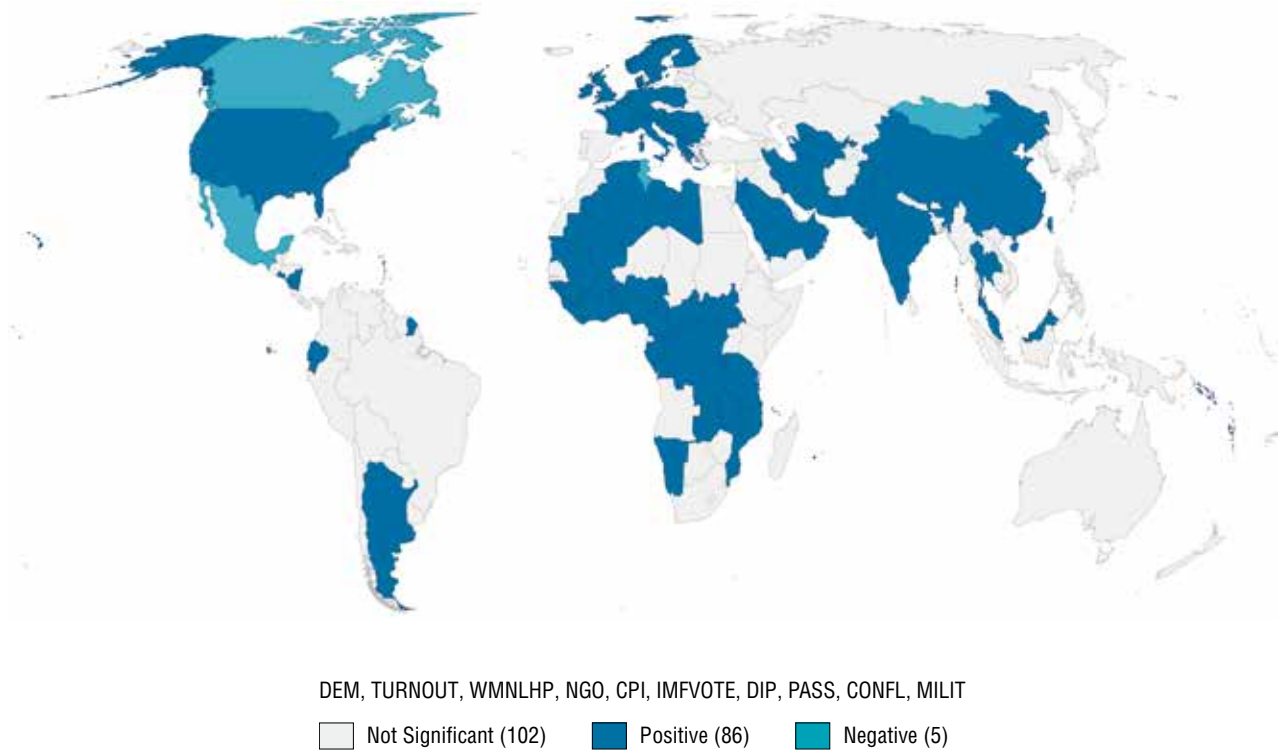


Fig. 5.11.1. "Politics" section spatial autocorrelation cartogram for the geometric neighbourhood matrix

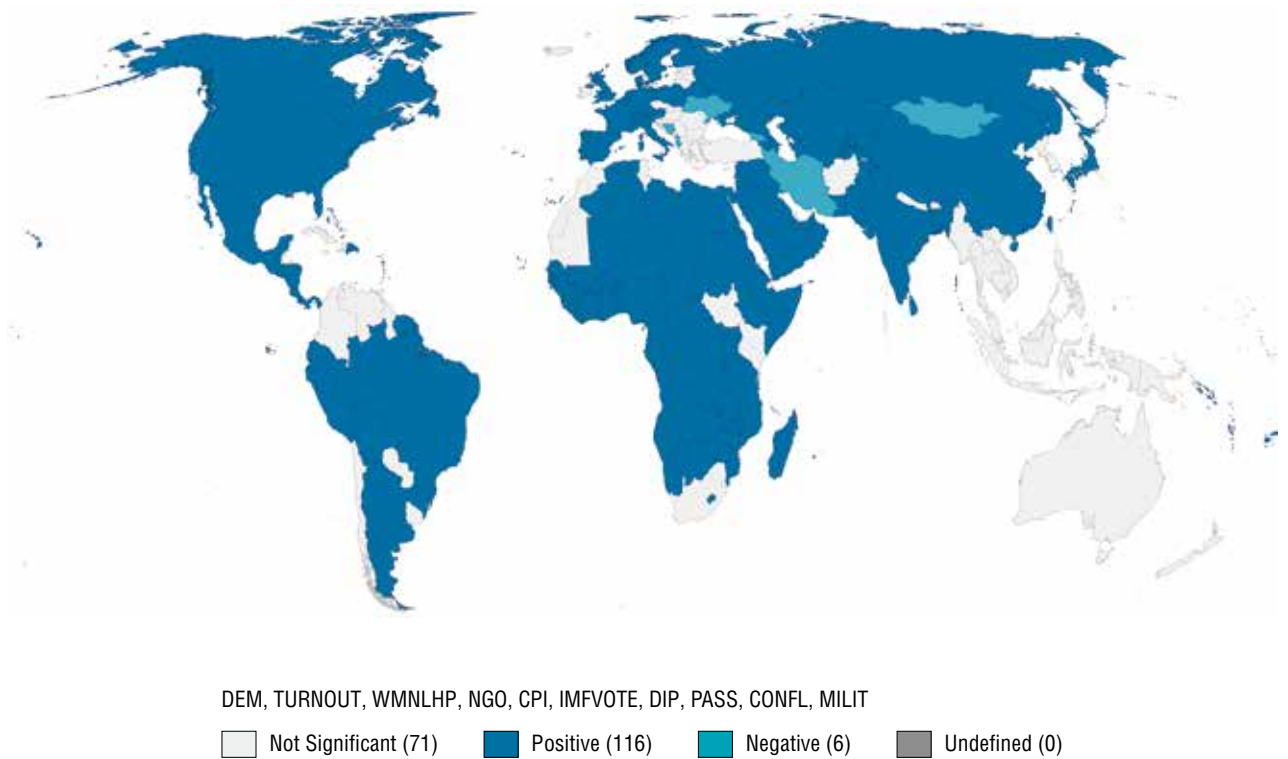


Fig. 5.11.2. "Politics" section spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

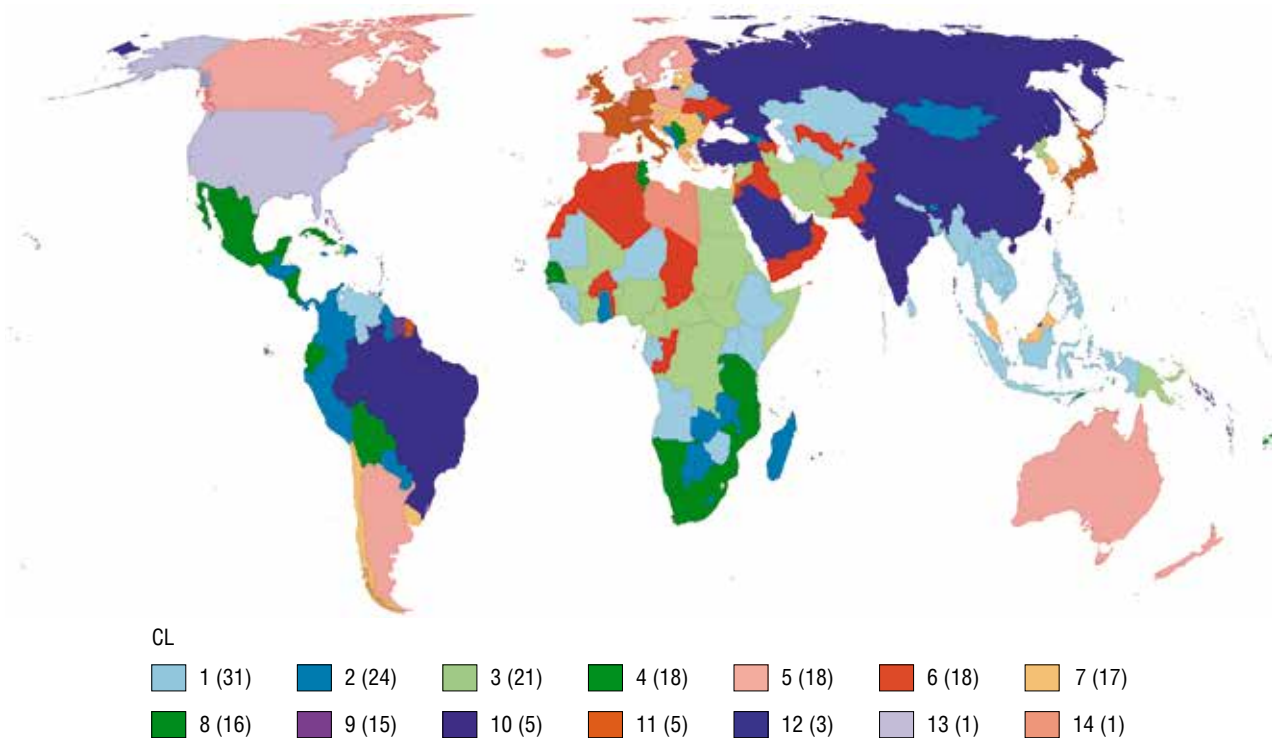


Fig. 5.11.3. Statistical clusters cartogram for the “Politics” section indicators

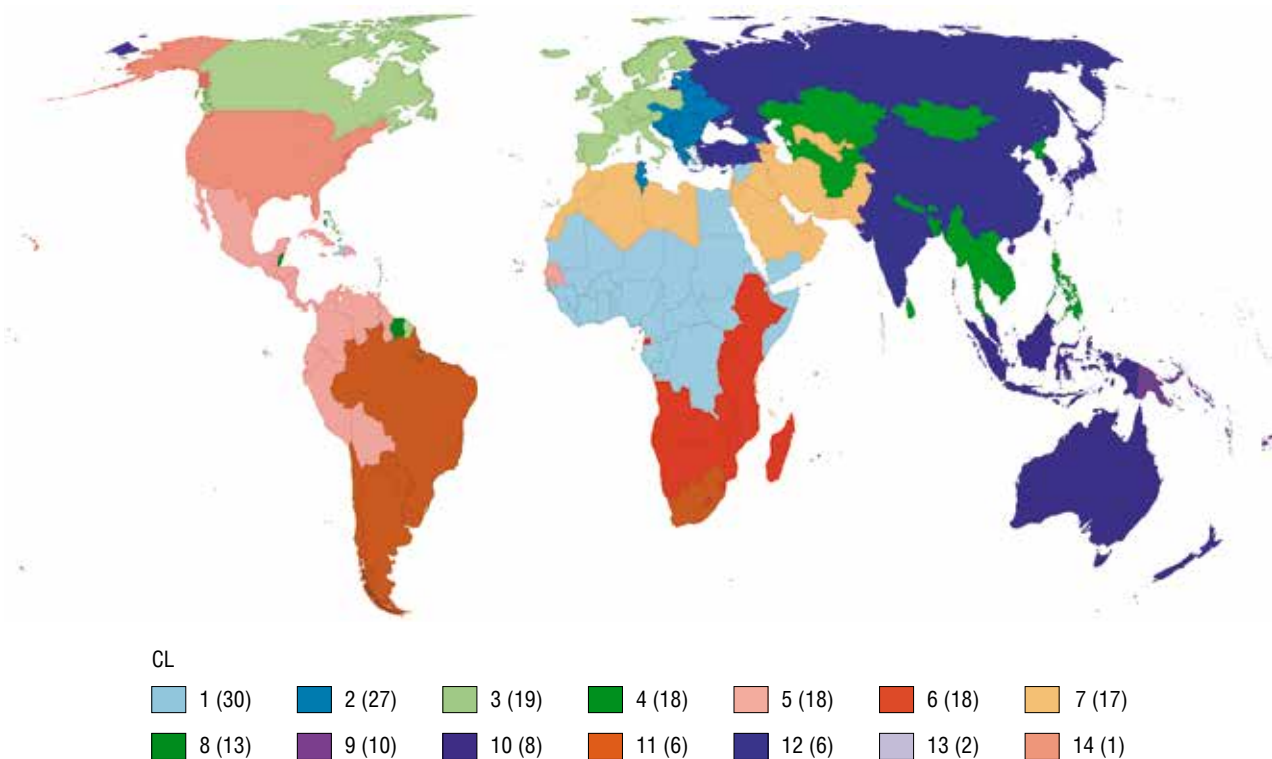
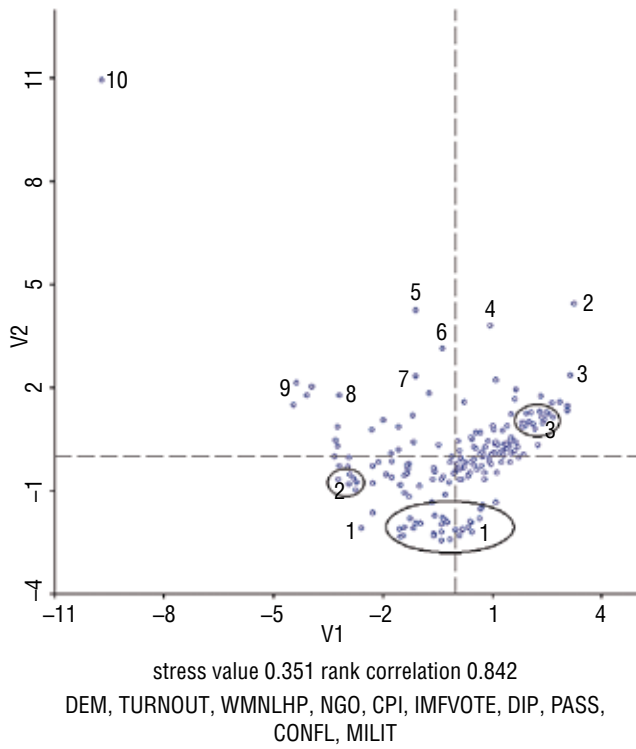


Fig. 5.11.4. Statistical clusters cartogram for the “Politics” section indicators adjusted for geographic proximity



1	Luxembourg
2	Libya
3	South Sudan
4	Saudi Arabia
5	China
6	Russia
7	India
8	Poland
9	France, UK, Germany, Japan
10	US

Fig. 5.11.5. Multidimensional scaling chart for the "Politics" section indicators

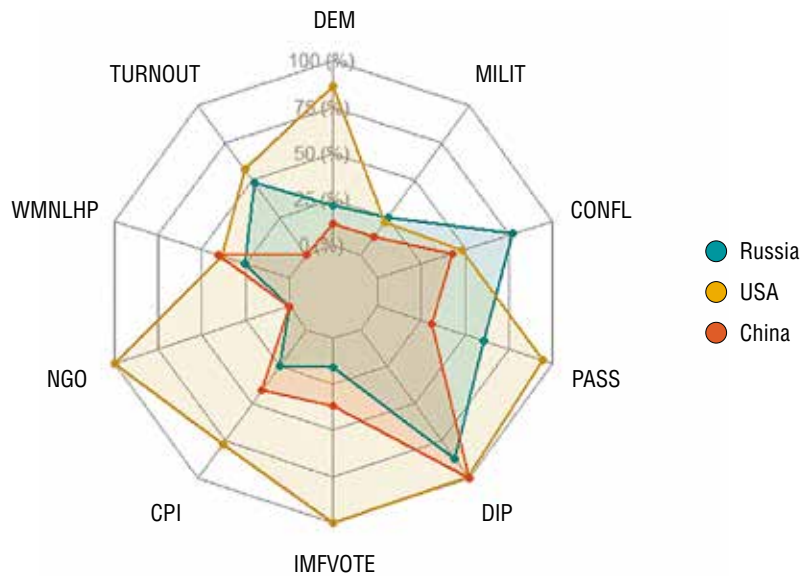


Fig. 5.11.6. Radar chart for the "Politics" section indicators

5.12. Spatial factor and “Politics” section indicators

Politics and political indicators describing the position of a given state on the international stage reflect the dependence on the spatial factor. For instance, Moran's I based on the geometric neighbourhood matrix was significant for three indicators out of ten in this section. The passport power indicator topped all the indicators in the Atlas for the geopolitical neighbourhood matrix (with a value of 0.621) and was the fourth indicator in the geometric neighbourhood matrix (with a value of 0.690). We may assume that such values are due to the fact that states located in the same bloc that enjoy friendly and trust-based (to a degree) relations have fewer migration barriers between them, which increases passport power and the free movement of their citizens. In this case, the neighbourhood effect plays a great role: the closer states are to each other, the more likely they are to have socioeconomic, political, historical and cultural points of contact and, consequently, fewer border restrictions.

Additionally, the Democracy Index indicator also made Moran's I's top ten for the geopolitical neighbourhood matrix (with a value of 0.525). This may be explained, first, by states imitating each other and borrowing those practices from their neighbours they see as most appropriate based on the sum total of historical, cultural, social, economic and political circumstances. Second, given that such values were obtained using the geopolitical neighbourhood matrix, we should note that democracy becomes an instrument used at the level of discourse to mark “friends” and “foes” on the political map — in other words, to delineate “democracies” and “autocracies,” which, in turn, divides the world into the collective West and the collective East.

Notably, however, all ten indicators considered in this section failed to confirm the hypothesis that geopolitical neighbourhood has greater significance compared to the geometric neighbourhood matrix, since Moran's I in geopolitics was always lower than in geometry, although the gap was frequently small.

As for common patterns for the ten indicators, the most frequent clusters of states included European Union countries, Eastern Europe countries, Fennoscandia, Caribbean countries, ASEAN countries, and the countries of the Maghreb and East and West Africa. Similar political indicators may be said to contribute, among other things, to regional integration, and the neighbourhood effect also frequently highlighted those very regions.

Two-factor indicator analysis shows the highest Moran's I values for the following pairings between political indicators and indicators from other groups: number of diplomatic missions and number of doctors (Moran's I — 0.273, spatial effect index — 0.983); number of women in lower houses of parliament and healthcare spending (Moran's I — 0.355, spatial effect index — 1.485); and, finally, democracy index and linguistic diversity coefficient (Moran's I — 0.348, spatial effect index — 1.485). Therefore, for these pairings, we may claim that the spatial effect makes a significant contribution to the global distribution of phenomena.

The two-factor spatial autocorrelation cartograms for linguistic diversity and the democracy index for both neighbourhood matrices (Fig. 5.12.1 and Fig.5.12.2) yields the following results. The geometric neighbourhood matrix produces two “error” clusters. The first includes European countries (with the exception of Italy, Belgium, Switzerland and the Netherlands). These European countries demonstrate low linguistic diversity coupled with high levels of democracy among their neighbours. Exceptions show high linguistic diversity levels and high democracy index among their neighbours. The second “error” cluster includes countries of West Africa (with the exception of Sudan), the Middle East (with the exception of Saudi Arabia), and Asia (with the exception of Mongolia, Vietnam, Cambodia, Turkmenistan and Georgia). This cluster of states exhibits a high level of linguistic diversity with low levels of democracy among their neighbours. The exceptions listed above are characterized by low scores for linguistic diversity coupled with low democracy index values among their neighbours.

The geopolitical neighbourhood matrix yields a larger number of clusters. The first is an “error” cluster that is characterized by low linguistic diversity coupled with high democracy index among its neighbours.

This cluster includes European countries and Turkey. Exceptions from this cluster are Italy, Albania, Bosnia and Herzegovina, the Netherlands, Latvia, Estonia and Ukraine, which belong to another cluster with high linguistic diversity and whose neighbours demonstrate high levels of democracy. Russia and Belarus form a cluster of low linguistic diversity coupled with high democracy scores among their neighbours. Kazakhstan, Uzbekistan and Kyrgyzstan form a common cluster that is characterized by high linguistic diversity values coupled with low democracy scores among their neighbours. ASEAN countries form a cluster with similar characteristics. The countries of the Maghreb, countries of West Africa (with the exception of Somalia, Sudan, Mauritania, Burundi, Rwanda and Equatorial Guinea) form a cluster with similar characteristics — low levels of diversity and low democracy index among neighbours.

Model selection criterion	Indicator	Value	Significance level
Normality of errors	JB p-value > 0,1	—	0,557965
Heteroskedasticity	K (BP) p-value < 0,05	—	0,000939
Multicollinearity	VIF < 7,5	1,409421	—
Spatial Autocorrelation	Moran's I p-value > 0,1	—	0,172981
Lagrange Multiplier — Geometry Weights	Lagrange Multiplier (lag)	6,0200	0,01415
	Robust LM (lag)	0,0274	0,86858
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (error)	11,7440	0,00061
	Robust LM (error)	5,7514	0,01648
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (lag)	24,6877	0,00000
	Robust LM (lag)	1,0562	0,30408
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (error)	60,9121	0,00000
	Robust LM (error)	37,2806	0,00000

	OLS	SEM geometry	SEM geopolitics
Constant	82,276624 (0,000000)	90,1586 (0,00000)	90,8643 (0,00000)
AGEPEDOLD	1,206534 (0,000000)	1,1674 (0,00000)	1,07913 (0,00001)
MARRG	-0,449664 (0,000003)	-0,464613 (0,01720)	-0,415685 (0,01351)
TAX	0,810200 (0,000000)	0,812635 (0,00414)	0,587006 (0,01995)
CONFL	-13,773439 (0,000000)	-16,1713 (0,00001)	-14,7195 (0,00000)
LAMBDA	—	0,348501 (0,00022)	0,620082 (0,00000)
Heteroskedasticity (Breusch-Pagan test)	18,605931 (0,000939)	12,1322 (0,01639)	10,7425 (0,02962)
Normality of errors (Jarque-Bera test)	1,166918 (0,557965)	—	—
Spatial dependence (Likelihood Ratio test)	—	0,01639 (0,00021)	35,3592 (0,00000)
Akaike info criterion	1644,15	977,522	955,883
Schwarz criterion		991,333	969,693
R-squared	0,694628	0,716343	0,774560

* P (P-value) significance level is given in brackets.

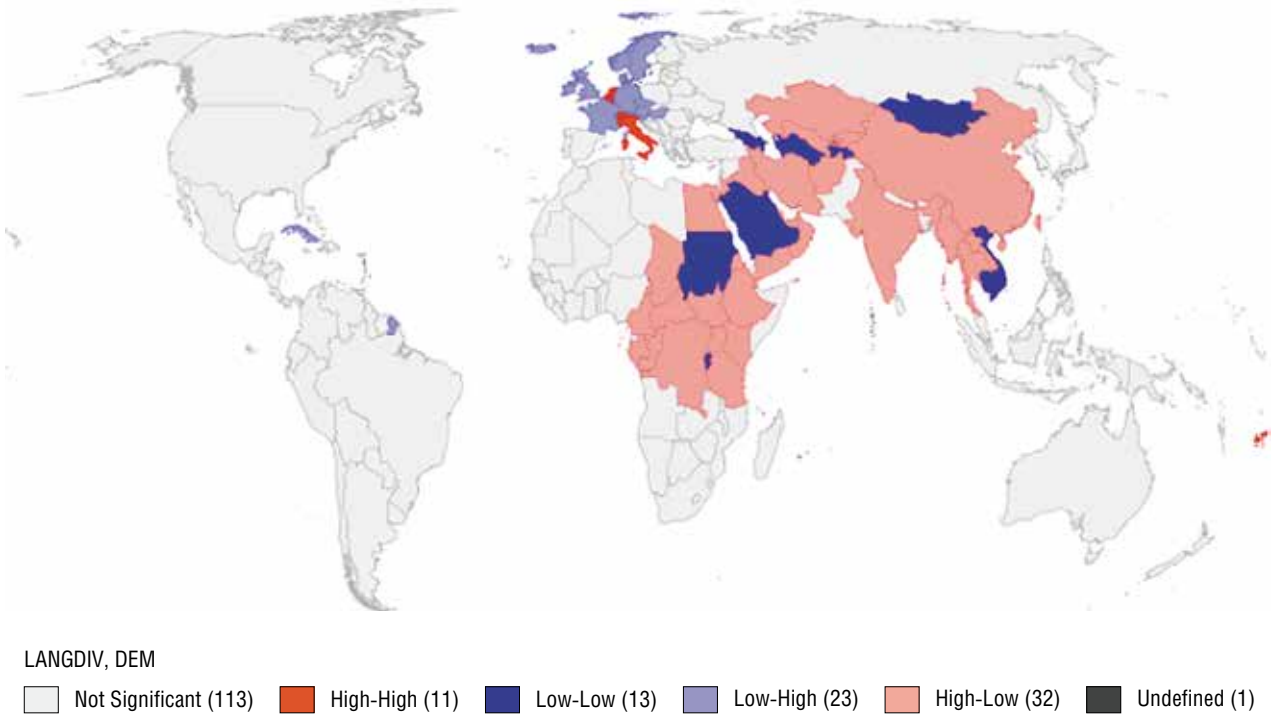


Fig. 5.12.1. Two-factor spatial autocorrelation cartogram for linguistic diversity and democracy index for geometric neighbourhood matrix

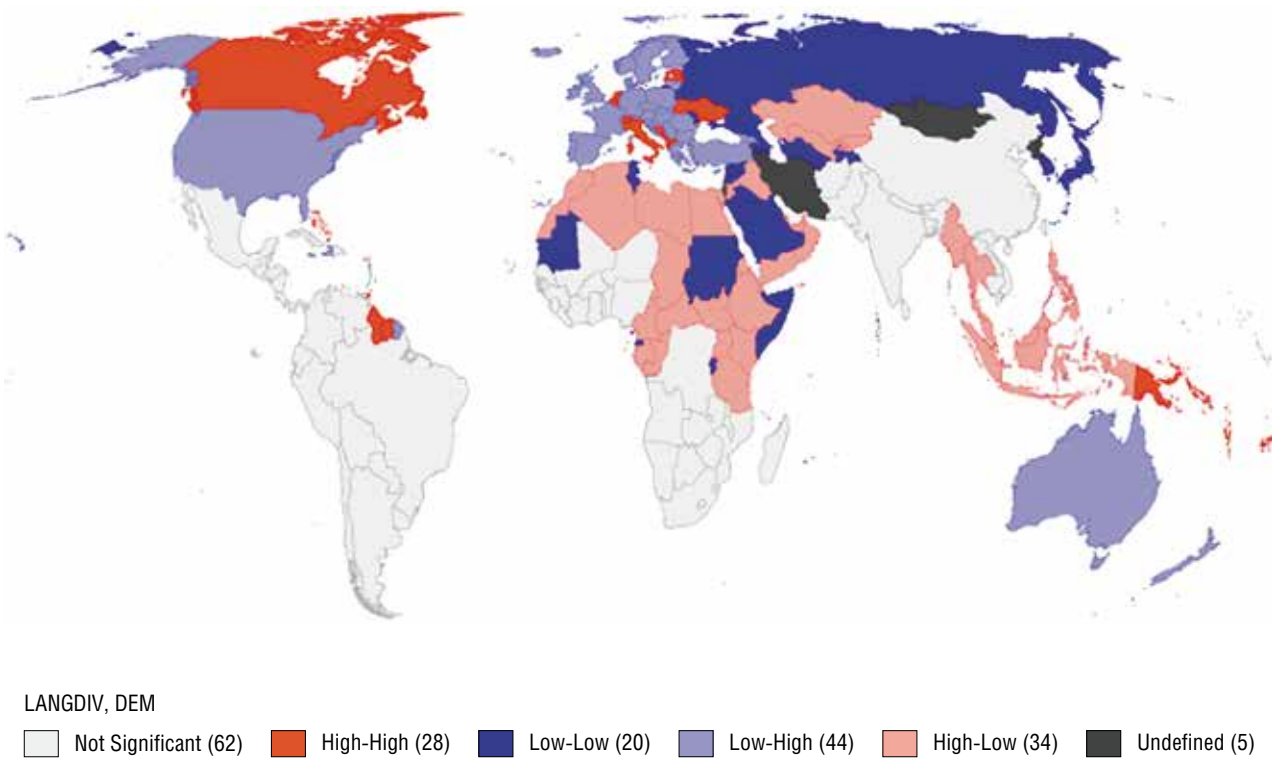


Fig. 5.12.2. Two-factor spatial autocorrelation cartogram for linguistic diversity and democracy index for geopolitical neighbourhood matrix

The ten-factor analysis yielded groups of countries with similar political indicator values, and the geopolitical neighbourhood matrix shows clusters with clearer outlines and practically fit into the clusters along the outlines of geopolitical splits.

The geographically weighted regression method revealed that the following model is the most valid for the section's indicators: a regressive dependence was identified for the level of democracy (DEM) on a combination of the following independent variables — dependency ratio — elderly population (AGEPEDOLD), tax revenues (TAX), percentage of women in a marriage/union (MARRG) and conflictogenity (CONFL).

The coefficient of determination is nearly 0.7, and the following hypotheses may be advanced:

- The higher the proportion of elderly population, the higher the level of democracy. This may be due to the fact that the overwhelming majority of democracies are countries of the West, which have ageing populations as well as strong democratic traditions that are revered and preserved.
- The smaller the number of married women, the higher the level of democracy. This hypothesis may likely be explained by the fact that unmarried women without a partner they may rely on count on themselves (for more detail see: Unmarried Women 2015), and, consequently, they need to have the same rights and freedoms as men [Hansen, Goenaga 2019], which, in turn, is typical for democratic societies.
- The higher a state's tax revenues, the higher the level of democracy. Presumably, this is because citizens who pay more taxes into their state's treasury will in return demand that political decision-making accounts for their opinion by using democratic institutions. Let us note, however, that some researchers believe that democracies rather result in greater direct tax burden [see, for instance: Gould, Baker 2002; Balamatsias 2017], while others insist that there is a U-shaped dependency, rather than a linear relationship [Garcia, von Handelwang 2016].
- The lower conflictogenity level, the higher the level of democracy. Some researchers note [Herge 2014] that this is primarily due to favourable socioeconomic conditions that result in more peaceful life, reduced conflictogenity, and, consequently, democracy. Additionally, there is the famous claim that "democracies don't start wars" and that democracies are conducive to peace [Ray 1998].

Using the Lagrange multiplier, the research team established that the spatial error model was preferable for use in both the geometric and geopolitical matrices. In other words, both geometric and geopolitical neighbourhood increases the model's efficiency. At the same time, the Akaike information criterion demonstrates that the spatial error model has far greater validity than the non-spatial model. The Schwarz information criterion shows that the spatial model based on the geopolitical neighbourhood matrix has greater validity than the spatial model based on the geometric neighbourhood matrix. This is evidenced by the R-squared value, which is higher when the geopolitical neighbourhood matrix is used compared to the geometric neighbourhood matrix.

The standard deviation cartogram shows that the model has the highest explanatory potential for such states as Mongolia, India, Sierra Leone, Ghana, Nigeria, Niger, Argentina, Guyana and Panama. Notably, this model offers a poor explanation for the case of Belarus. Let us also note that this model has a low significance level for China and the countries of Eurasia (with the exception of Mongolia).

Therefore, globally, the spatial factor may appear to have little significance since states do not attempt to copy the best examples and live each in its own way. However, when the spatial factor is considered regionally, as we have seen, for instance, on the spatial autocorrelation cartograms for linguistic diversity and democracy index, we can observe certain mimicry of neighbouring states. Certainly, political processes and the political structure of different societies are variegated and multifaceted, which, in turn, results in the neighbourhood effect manifesting itself differently for different indicators and in different regions. A spatial analysis is useful in this case insofar as it shows the global variety of states on the one hand and, on the other, highlights those points of contact that make it possible to cluster countries, find similar ones among them, and maybe identify not only those that should probably be imitated, but also those with which deeper similarity-based connections may be established.

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6

Equality

Poverty level

Economic inequality

Highly wealthy population

Unemployment

Female unemployment

Female labour

Maternal mortality

Gender parity at school

Hospital beds

Access to electricity

*Multifactor analysis of the “Equality”
section indicators*

*Spatial factor and “Equality”
section indicators*

“**E**QUALITY” is an inter-disciplinary section spanning a set of issues connected with the economy, demographics, healthcare, education and politics. At the same time, defining equality as a public phenomenon is a complicated and challenging task that researchers and experts have been grappling with for a long time [Westen 1982; Karst 1982], and the urgent social nature of the topic does nothing to make the process of formalization any easier. On the contrary, it only makes it more difficult. Therefore, the research team interprets equality in the broad sense of the term, relying on the definition presented by researchers from the London School of Economics: “An equal society protects and promotes equality of valuable capabilities — the central and important things that people are able to do and to be — so that everyone has the substantive freedom to live in ways that they value and choose (and have reason to value and choose). An equal society recognises the diverse needs, situations and goals of individuals, and seeks to expand their capabilities by removing discrimination and prejudice and tackling the economic, political, legal, social and physical conditions that constrain people’s achievements and limit their substantive freedom” [Burchardt, Vizard 2007]. Equality, therefore, is interpreted as “equality of capability” based on the approach developed by economist and Nobel prize winner Amartya Sen [Alkire 2005].

Equality and its opposite, inequality, can be viewed in several dimensions [Walby et al. 2008].

- socioeconomic status (income, access to healthcare and education);
- gender (gender equality);
- race and ethnicity;
- disability (for disabled persons);
- age;
- religion;
- sexual persuasion etc.

On the one hand, equality appears to be an operationalizable category for the aspects listed [Burchardt 2006], yet on the other hand, the number of indicators that help provide a quantitative assessment of this phenomenon by country is very limited. Socioeconomic and gender equality indicators have the greatest scope. Consequently, we included the following indicators in our research:

- economic: poverty level (%), Gini coefficient (points), income of the top 20% of the population (%);

- social: unemployment (%), hospital beds per 10,000 population, population (points) percentage with access to electricity (%);
- gender: female labour (%), female unemployment (%), maternal mortality (points), gender parity index in school education (points).

The multidisciplinary nature of some indicators from other sections also makes it possible to classify them as indicators describing equality: infant mortality rate, female representation in lower houses of parliament, and internet access. Currently, experts increasingly speak of digital inequality and internet access as a civil right [DiMaggio et al. 2004]. It is also important to list the indicators that were rejected at the selection stage: statistics on disabled persons (UN Disability Statistics, small country sampling), the egalitarian Democracy Index (V-Dem, the indicator is comprehensive and based on expert assessments), and the number of lawsuits filed in international courts against the government over any forms of discrimination (small country sampling). Other indicators, such as racial and ethnic discrimination, ageism, persecution of sexual minorities, percentage of women holding high positions in companies, are tracked regionally and nationally (mostly in western democracies), consequently, they also could not be included in the Atlas.

The World Bank's World Development Indicators database served as the main source of research data. The hospital beds indicator was taken from the WHO's Global Health Observatory data repository.

Socioeconomic equality indicators form the cornerstone of this section. These indicators may be studied in two aspects: as intra-country and inter-country inequality. Nevertheless, researchers faced the problem of the frequency of national statistical monitoring for the three main indicators characterizing equality (poverty level, Gini coefficient, and income of the top 20% of the population): for more than 40 countries, the latest relevant figures were recorded in 2006–2015. Consequently, the research team decided to include these figures (most recent value) in the general totality in order to ensure a representative country sampling. The researchers proceed from the premise that the situation with economic inequality changes fairly slowly [Banerjee 2008] and that a period of 10–15 years may be considered logical for recording global economic inequality trends.

At the indicator level, we need to point out certain aspects connected with one key indicator, namely, poverty. The World Bank distinguishes several thresholds for assessing poverty: USD 2 for countries with low GDP per capita; USD 3.2 for countries with medium GDP per capita; and USD 5.5 for countries with high GDP per capita. Each country also sets their own national poverty thresholds individually. International researchers and experts have repeatedly noted the faults inherent in absolute poverty thresholds [Fisher 1994; Osberg 2000]. Consequently, we chose the national poverty threshold as the poverty level indicator since the purchasing power of the same income may be entirely different, for instance, in Austria and in Cambodia.

A large block in this section focuses on gender equality as one of the most tracked trends of the 21st century and one of the sustainable development goals [Agarwal 2018]. The list of indicators does not cover all the aspects of gender equality due to the shortage of data (bodily autonomy as the right to dispose of one's body without outside domination or coercion, autonomy in one's family, political power, access to material resources [land and loans], access to employment and income including distribution of unpaid amounts, and the use of time [leisure and sleep]) [Dijkstra 2006], but spans such important dimensions as access to employment (female unemployment and female labour), schooling (gender parity index) and, indirectly, healthcare (maternal mortality).

Hospital beds per 10,000 population as an inequality indicator was analysed, among other means, through spatial econometrics methods and mostly at the national level, for instance, in China [Lu, Zeng 2018], Bangladesh [Alam, Ria 2018] and Iran [Chavehpour et al. 2019], and this is the first attempt to generalize the global experience in this area.

Access to electricity should also be viewed as an indicator that could tell us about the situation with equality and poverty, since having access to this public good has a positive effect on education outcomes and healthcare [Kanagawa, Nakata 2008].

6.1. Poverty level

Poverty level is an indicator that shows the percentage of a given country's population that lives below the poverty line. The World Bank Group calculates poverty using standards applied to the poorest countries. However, this section uses national thresholds established by each country individually.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.460	0.000	0.435	0.000
Geary's C	-0.535	0.000	-0.554	0.000

The percentile cartogram (Fig. 6.1.1) shows that the highest poverty indicators are demonstrated by countries of sub-Saharan Africa. Countries with low scores on the poverty indicator are mostly located in Europe and East and Southeast Asia. For European countries, poverty has not been a pressing problem, which is understandable given that the continent is dominated by developed states. At the same time, the low poverty rates in Asia can be explained by the fact that countries have differing perceptions of poverty rates and, consequently, different national thresholds. For instance, in Austria, this threshold equals €1328 per month, while in Vietnam, it is USD 150 per month. A moderate positive connection is observed in assessing this indicator. The geopolitical neighbourhood matrix yields lesser spatial correlation than the geometric matrix, yet the proximity of values does not allow us to either confirm or refute the hypothesis that the international structure has greater significance.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 6.1.3) shows three clusters: two with high poverty levels, both located in Africa (the sub-Saharan countries, with the exception of Botswana and Tanzania and a cluster of West African countries — Mali, Guinea, Senegal and Sierra Leone); and one low-value cluster in Eurasia. High levels of poverty have been a crippling problem in Africa since the 1960s, when decolonization created many new states with weakly developed political institutions and a low quality of life. However, Botswana is an exception here, having left the group of least developed countries in 2004 thanks to its high GDP growth rates on the back of its diamond production industry. At

Global place	Country	Indicator (%)
1	Congo	40.90
2	Niger	40.8
3	Nigeria	40.1
Mean (56)	(Lebanon)	27.75 (27.4)
Median (77)	Latvia	22.9
151	Kazakhstan	2.5
152	Ukraine	1.3
153	China	0.6

the same time, we should note that Botswana has set one of the world's lowest poverty thresholds: USD 1 per day, which also contributes to the low poverty rates in the country. Dropping poverty indicators in the regions that had once been leaders in this area (South and Southeast Asia) may also be explained by the campaign to eradicate poverty introduced under the auspices of UN-led international organizations [Massarova & Potapenko 2018].

The geometric matrix demonstrates one “error” case, Tanzania, which may be explained by valid data being available mostly for urban poverty, where threats to food security do indeed drop to mean values. The Eurasian cluster of low values demonstrates insufficient spatial autocorrelation for the developed countries of Northern Europe (Finland, Sweden), the Baltic states and Belarus.

The geopolitical neighbourhood matrix yields larger clusters of countries with high poverty levels: on the cartogram (Fig. 6.1.4), this is essentially the whole of sub-Saharan Africa (with the exception of Namibia and Botswana). These exceptions correspond to the percentile cartogram where Namibia and Botswana were also among the countries with mean poverty levels. The geopolitical neighbourhood matrix skewed a cluster of low poverty indicator values into Europe: the geopolitical structure here identified a more unambiguous cluster. However, neither the geopolitical, nor the geometric matrix yielded the kind of clustering in South and Southeast Asia that would confirm the findings of the percentile cartogram.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Poverty” parameter confirmed the African and European clusters (Fig. 6.1.2). Extremely dense connections are also observed in the countries of the Caribbean. However, neighbourhood matrices did not identify any clustering in this region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	IMF voting power	0.120	0.000	0.361	1.086
2	Light pollution	0.080	0.000	-0.280	0.980
3	Population growth	0.229	0.000	0.412	0.741
4	Ethnic minorities	0.026	0.030	0.138	0.732
5	Export	0.035	0.015	-0.157	0.704
6	Services sector	0.247	0.000	-0.414	0.694
7	Import	0.149	0.000	-0.319	0.683
8	Unused export potential	0.373	0.000	0.503	0.678
9	Linguistic diversity	0.385	0.000	-0.509	0.673
10	Industry	0.317	0.000	0.460	0.668

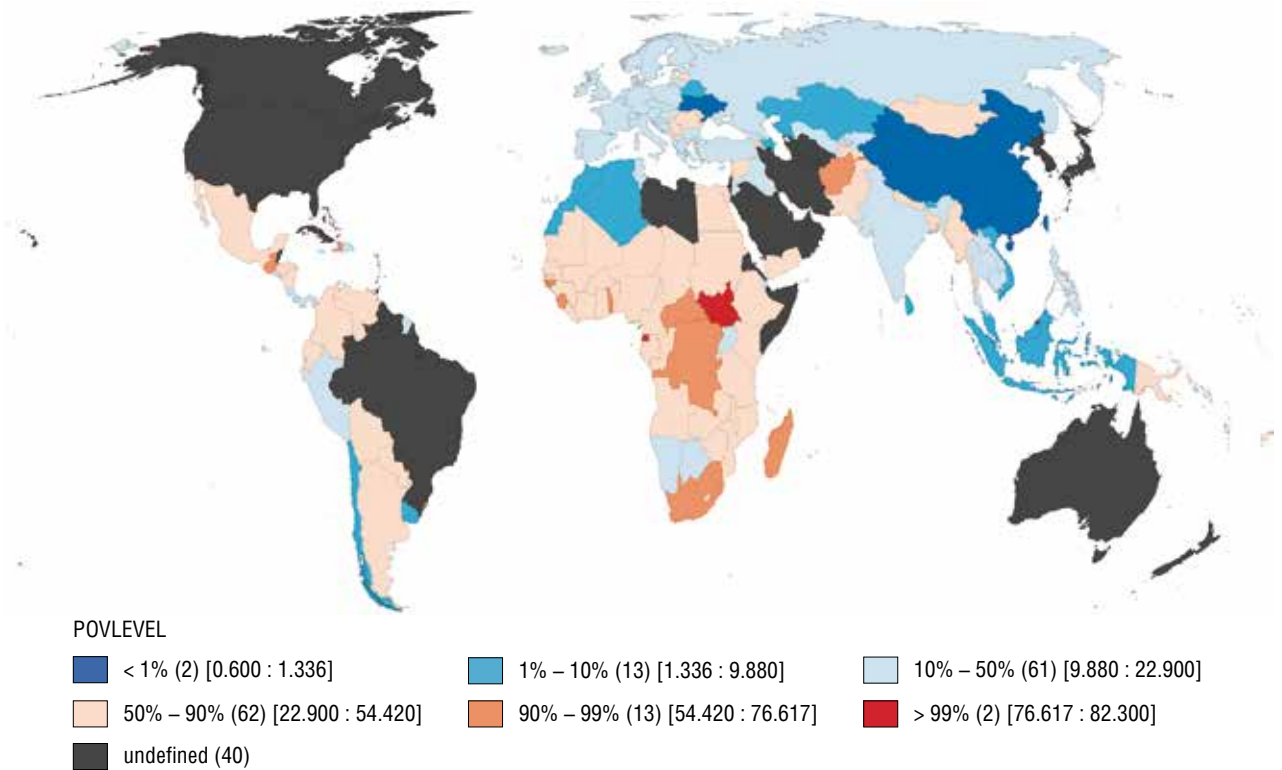


Fig. 6.1.1. Percentile cartogram for the “Poverty” indicator

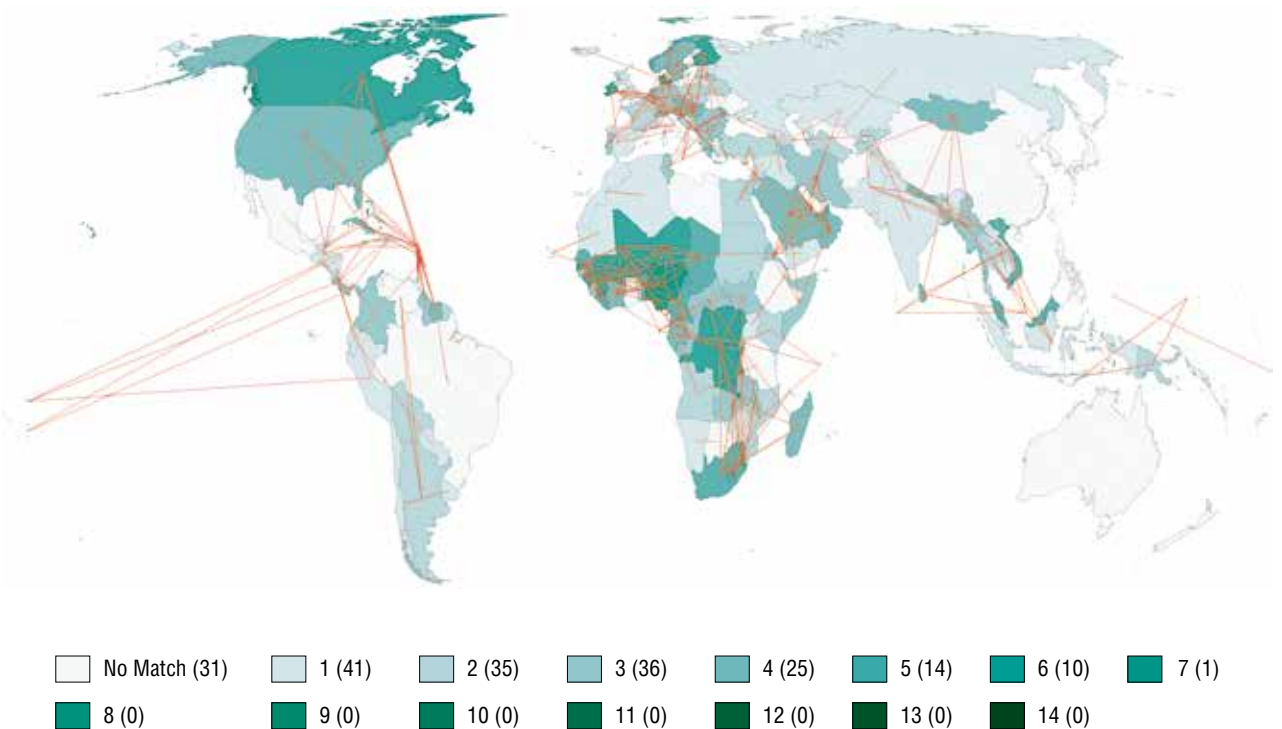


Fig. 6.1.2. Likelihood-ratio test for the “Poverty” parameter

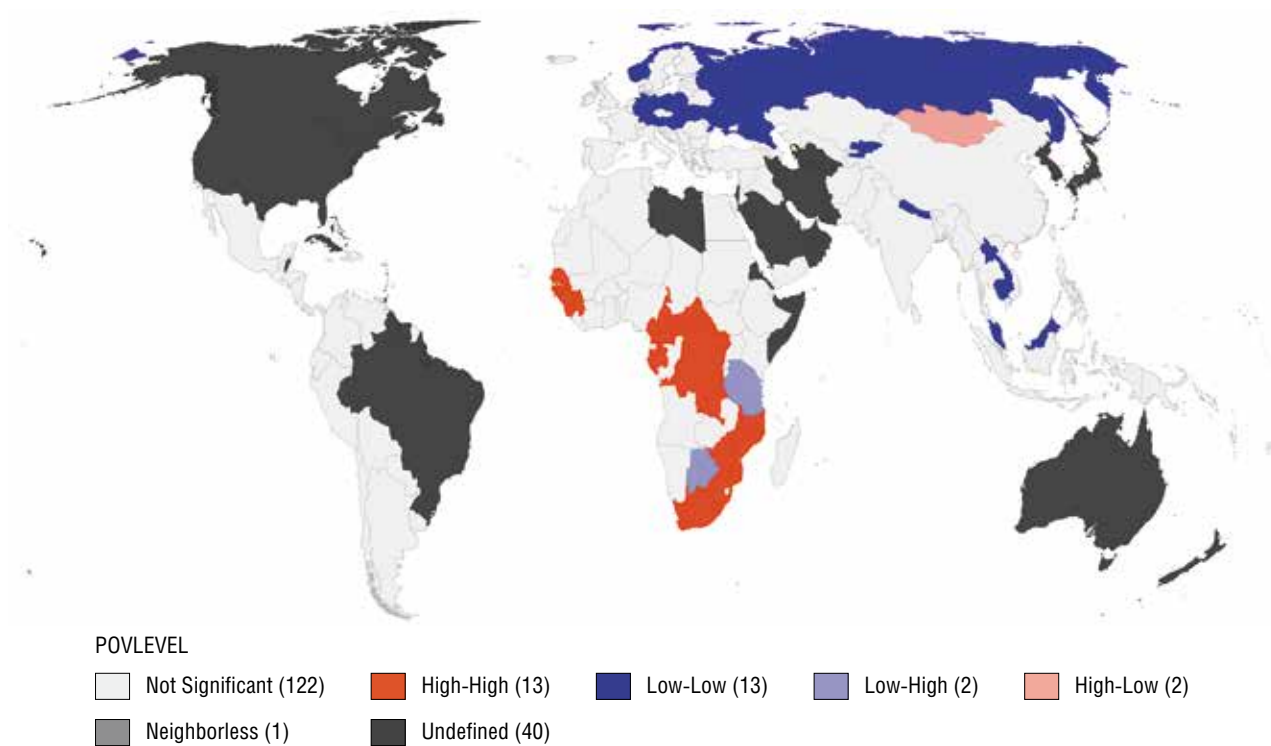


Fig. 6.1.3. “Poverty” spatial autocorrelation cartogram for the geometric neighbourhood matrix

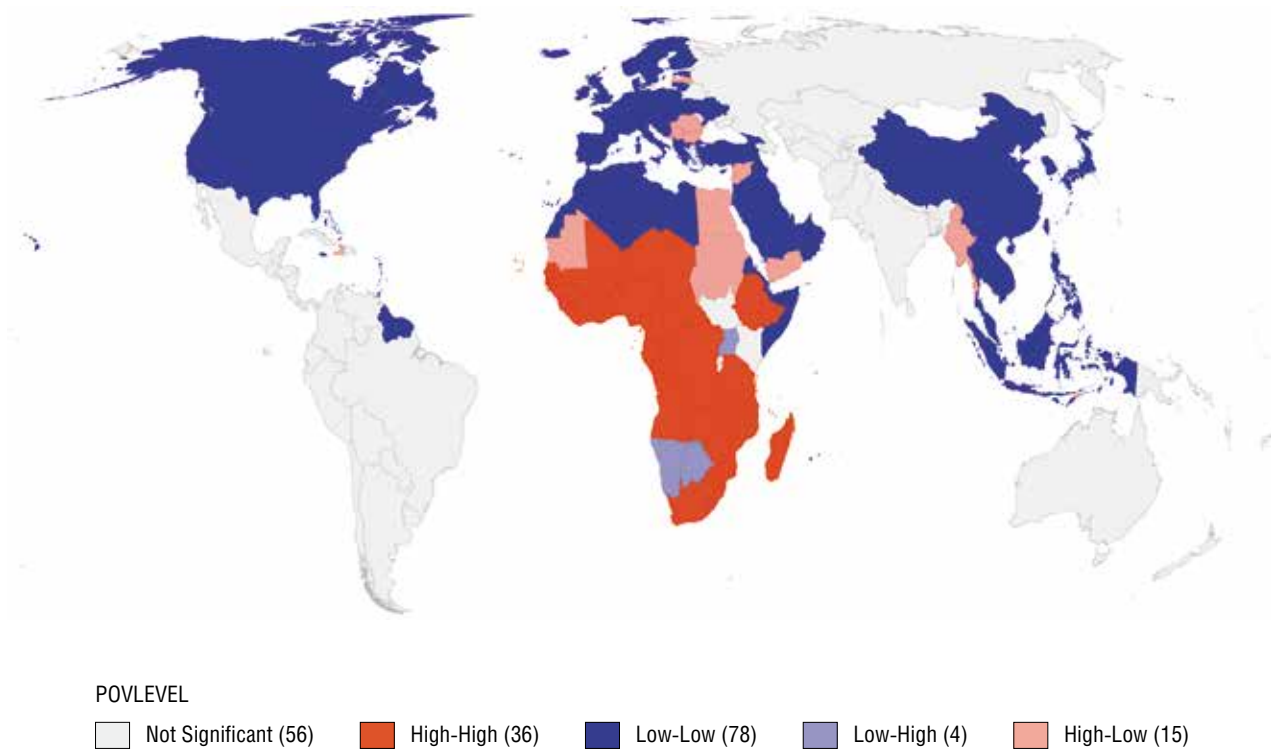


Fig. 6.1.4. “Poverty” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.2. Economic inequality

The Gini coefficient is the main indicator of economic inequality, measuring deviation from perfectly equal income distribution between individuals or households. The percentile cartogram shows that the countries with the highest economic inequality are concentrated in Latin America and sub-Saharan Africa (Fig. 6.2.1). Countries with low Gini coefficients are concentrated in Europe, the post-Soviet space (with the exception of Russia), West Africa and Southeast Asia. Low Gini coefficient scores may be explained by two dimensions: in small economies, high absolute poverty may exist next to low absolute poverty so that economy does not have sufficient surplus product to enhance social differentiation. Another dimension involves large economies with well-developed social and democratic institutions that mitigate social differentiation with sufficient surplus product. The indicator demonstrates a moderately positive correlation, with geopolitical neighbourhood matrix yielding a greater spatial correlation than the geometric matrix, and consequently, the hypothesis that the world's geopolitical structure has greater significance is confirmed for the spatial distribution of economic inequality.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.325	0.000	0.472	0.000
Geary's C	0.676	0.000	0.645	0.000

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 6.2.3) shows three clusters: two with high economic inequality levels (Latin American and African clusters) and one with low levels (Eurasian cluster). The Latin and Central American cluster includes the north of South America, as well as Nicaragua, Costa Rica, Honduras and Panama; the exception here is Guyana. The African cluster includes all sub-Saharan countries except Equatorial Guinea that belong to countries with high and very high values on the percentile cartogram. The sources of such inequality in both clusters lie in the colonial past, when colonizers enshrined social differentiation. In Latin America, it is also due to the flawed taxation system, where the tax burden for businesses and individuals is insufficient to effectively redistribute the

Global place	Country	Indicator (points)
1	South Africa	63
2	Namibia	59.1
3	Zambia	57.1
Mean (69)	Gabon	38.8 (37.96)
Median (78)	Mauritius	36.8
153	Belarus	25.2
154	Czech Republic	24.9
155	Slovenia	24.2

population's income [Lledo et al. 2004]. Thus, Latin America remains a region with the highest economic inequality indicators [Kholina, Massarova 2013].

Central and Eastern Europe belongs to the cluster of low spatial autocorrelation values. Notably, this cluster also includes Tunisia, thanks to its proximity to Italy, while Belarus and the Baltic states do not exhibit sufficient spatial autocorrelation. Additionally, Russia is part of this cluster, even though it demonstrates an above-mean indicator on the percentile cartogram, while Kazakhstan did not make this cluster precisely because it neighbours Russia and China. The geometric matrix shows a single “error” case: Guyana in Latin America, presumably because of its institutional British colonial heritage.

In the geopolitical neighborhood matrix cartogram, the world appears more clustered (Fig. 6.2.4). The Euro-Atlantic group and the CSTO-EAEC-CIS bloc form a heterogeneous space with relatively high economic inequality. The countries of Benelux and Scandinavia, Iceland, and Central and Eastern Europe fall into the error group. African and Latin American clusters now comprise greater numbers of states compared to the findings yielded by the geometric matrix: in South and Central America, the cluster expanded to include Mexico, while in Africa, the cluster now includes Chad and Madagascar. Only Mauritius shows a low value error against the high values of its neighbours. This additionally confirms the hypothesis that geopolitical structure plays a major role in economic inequality.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Economic inequality” parameter confirms previously obtained conclusions: a high density of connections is observed in Europe, Africa, and the Caribbean (Fig. 6.2.2). Similar values in the east and southeast of Asia did not yield any corresponding clustering for either geometric or geopolitical matrix.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Population growth	0.0776	0.418	0.000	2.252
2	Loans to domestic companies	0.041	-0.28	0.013	1.913
3	Alcohol consumption	0.032	-0.226	0.028	1.620
4	Air passengers	0.065	-0.319	0.001	1.574
5	Linguistic diversity	0.028	0.203	0.037	1.458
6	Infant mortality	0.124	0.408	0.000	1.344
7	Maternal mortality	0.076	0.317	0.001	1.322
8	Access to electricity	0.113	-0.385	0.000	1.313
9	Young population	0.182	0.474	0.000	1.235
10	Elderly population	0.183	-0.463	0.000	1.170

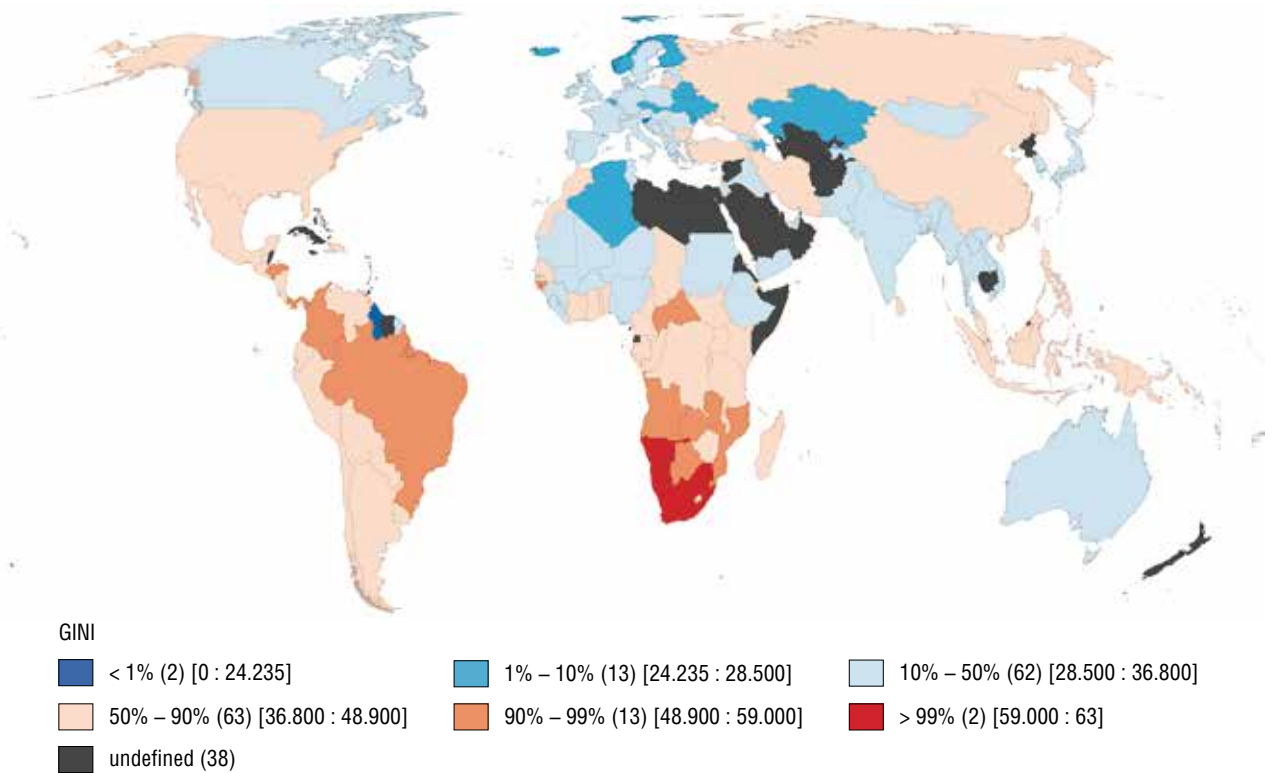


Fig. 6.2.1. Percentile cartogram for the “Economic inequality” indicator

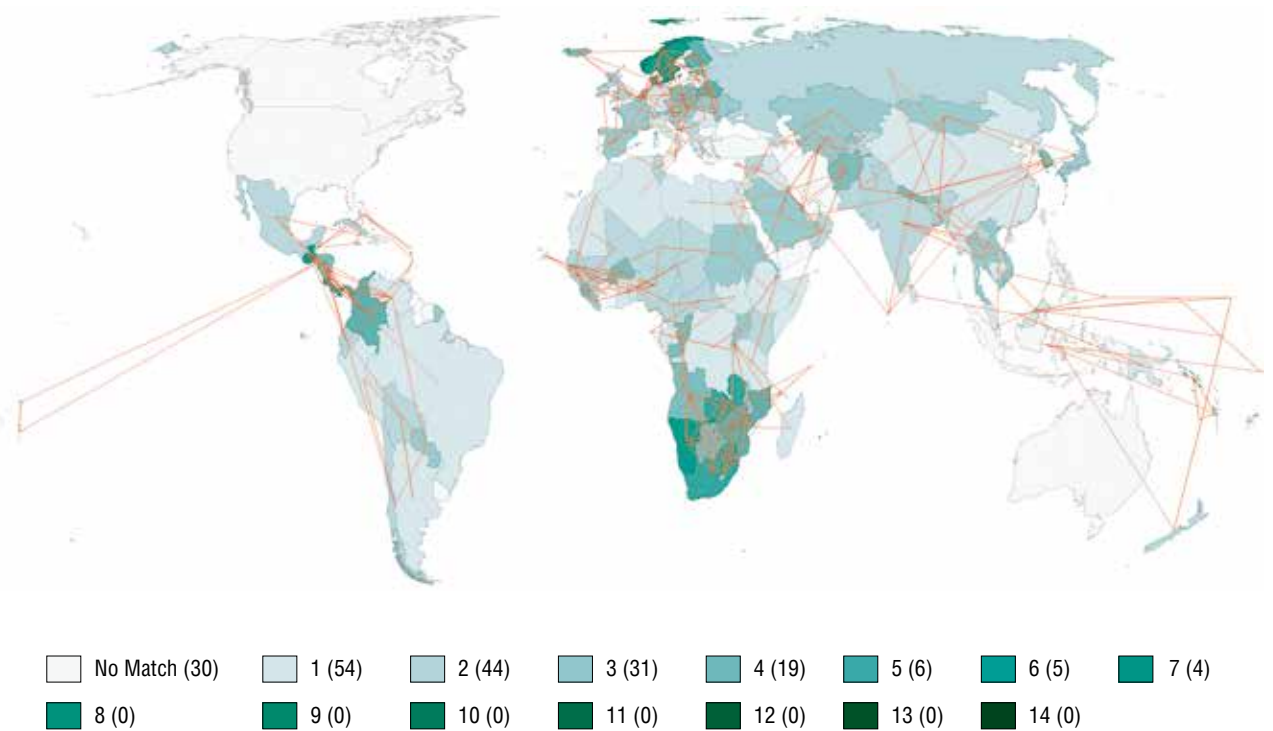


Fig. 6.2.2. Likelihood-ratio test for the “Economic inequality”

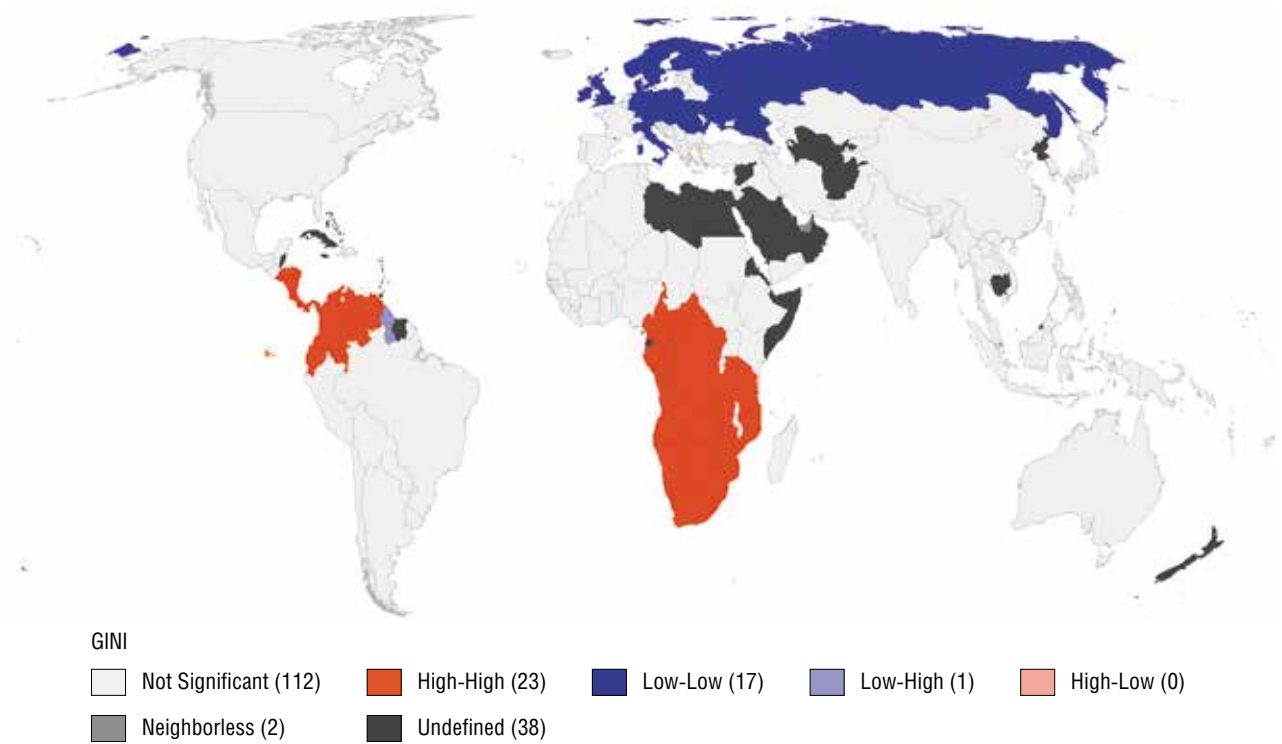


Fig. 6.2.3. “Economic inequality” spatial autocorrelation cartogram for the geometric neighbourhood matrix

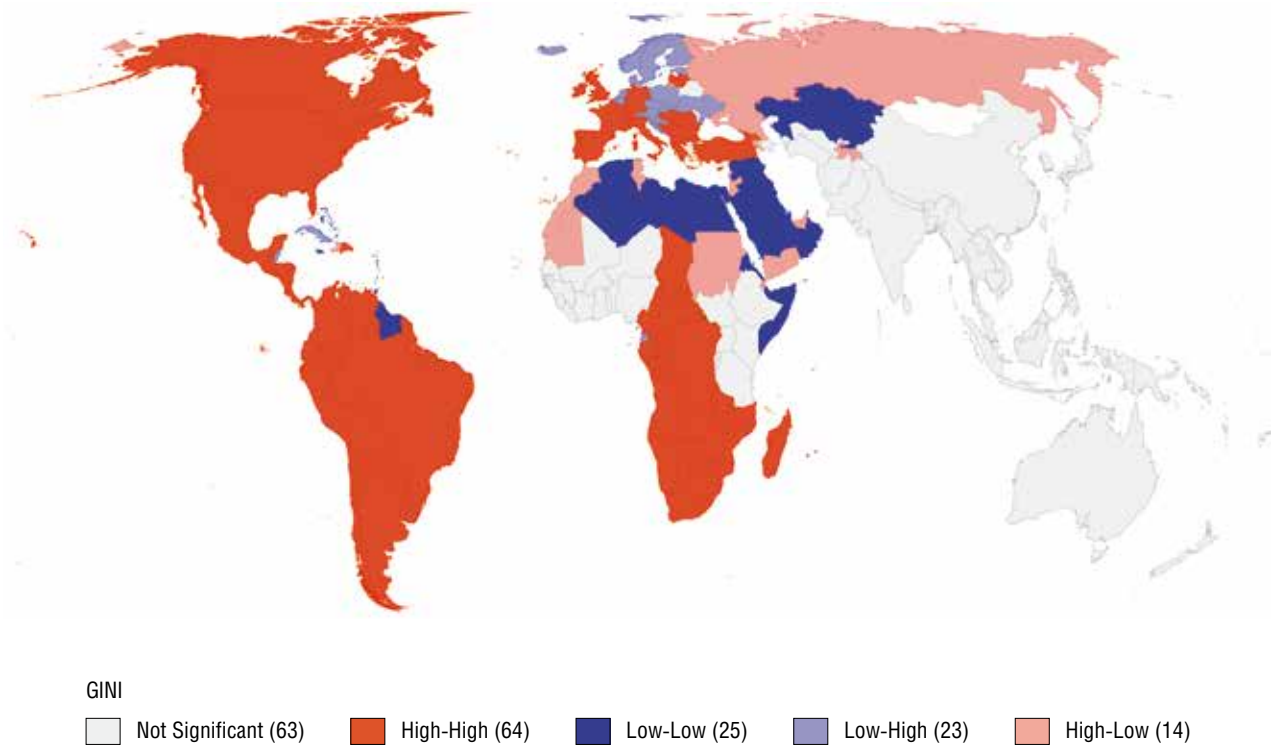


Fig. 6.2.4. “Economic inequality” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.3. Highly wealthy population

The “Highly wealthy population” indicator measures the percentage of income for the top 20% of the population in a given country. Along with the Gini coefficient, data on income distribution serves as the key factor in assessing the inequality level in a given country.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.282	0.000	0.307	0.000
Geary's C	0.714	0.000	0.689	0.000

The results, represented as a percentile cartogram, correlate with the data obtained for the Gini coefficient (Fig. 6.3.1). Countries where the wealthiest 20% of the population own the largest share of the wealth, are concentrated in South Africa and other Southern African countries, as well as in Latin America. The lowest concentration is observed in the Scandinavian countries, where social democracy regimes have been firmly established, as well as in Canada, Kazakhstan and Australia. This can be explained by the income redistribution mechanism: as a rule, developed economies mitigate social differentiation through re-distribution implemented by the authorities, while small economies suffer from accumulation of wealth in the hands of elites. This indicator demonstrates a moderate positive connection with the geopolitical matrix yielding greater spatial correlation than the geometric matrix, so the hypothesis of the dominant significance of geopolitical structure of the world is confirmed for the spatial distribution of economic inequality by Country.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix identifies two large clusters: the first has high percentage of revenues concentrated in the hands of the highly wealthy population and includes the whole of Southern Africa and part of Central Africa; the second spans most European countries, including Russia, where the scores for the indicator are low (Fig. 6.3.3). In African regions, such figures for this indicator are connected with high socioeconomic inequality. The income of the bottom 40% of the population corresponds to the lowest figures, while the first quintile concentrates maximum economic

Global place	Country	Indicator (%)
1	South Africa	68.2
2	Namibia	63.7
3	Zambia	61.3
Mean (69–70)	El Salvador, China	45.3
Median (76–78)	Gabon, Bhutan, India	44.4
152	Czech Republic	35.4
153	Slovenia	34.4
154	Slovakia	34

goods in a given country. The second cluster does not include the Baltic countries and Belarus, thereby showing insufficient spatial autocorrelation. We should also note that Russia made this cluster, despite its above-mean indicator values on the percentile cartogram. Meanwhile Kazakhstan, on the contrary, was excluded from the cluster because it neighbours China and Russia.

The geopolitical neighbourhood matrix (Fig. 6.3.4) identifies a greater number of clusters, which is logical in view of greater spatial autocorrelation. Two large clusters with high income indicators for the highly wealthy population are sub-Saharan Africa (with the exception of Lybia and East Africa) and the whole of Latin America. Two low-value clusters are Canada and the entire European continent, including Russia (the cluster also includes Kazakhstan, Kyrgyzstan and Tajikistan because of the neighbourhood factor). Cases of the so-called statistical “error” are Lybia in Africa and Guyana in Latin America. The latter case is explained by the British colonial legacy that left behind effective political institutions. The case of Sudan is not explained by institutional factors, since the state is riven by civil conflicts, yet the exacerbation of ethnic conflicts in the country could have resulted in an overall drop in the incomes of all population cohorts and in mitigating socioeconomic differentiation because organizations stepped up their work to fight for the rights of under-privileged population groups.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Highly wealthy population” parameter partially confirms previously identified clusters, while connections between Russia and other Eurasian states are not confirmed (Fig. 6.3.2). Intensive connections are also observed in Southeast Asia, where no cluster has been identified.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Inbound tourism	0.034	−0.327	0.031	3.187
2	Population growth	0.091	0.418	0.000	1.912
3	Alcohol consumption	0.039	−0.269	0.014	1.852
4	Loans to domestic companies	0.055	−0.314	0.004	1.777
5	Renewable energy	0.044	0.246	0.009	1.381
6	Maternal mortality	0.091	0.344	0.000	1.303
7	Hepatitis B vaccinations	0.027	−0.186	0.048	1.287
8	Infant mortality	0.161	0.448	0.000	1.244
9	Access to electricity	0.137	−0.41	0.000	1.230
10	Female labour	0.048	0.241	0.007	1.223

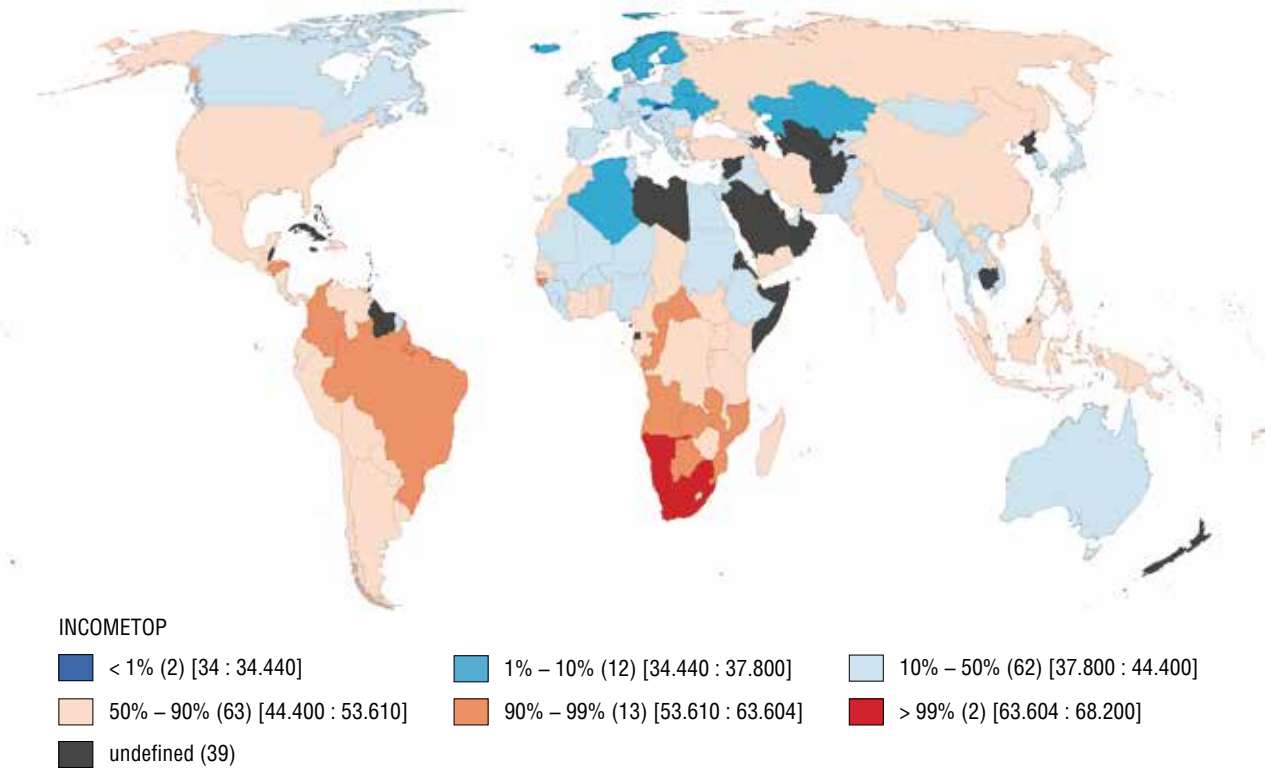


Fig. 6.3.1. Percentile cartogram for the “Highly wealthy population” indicator

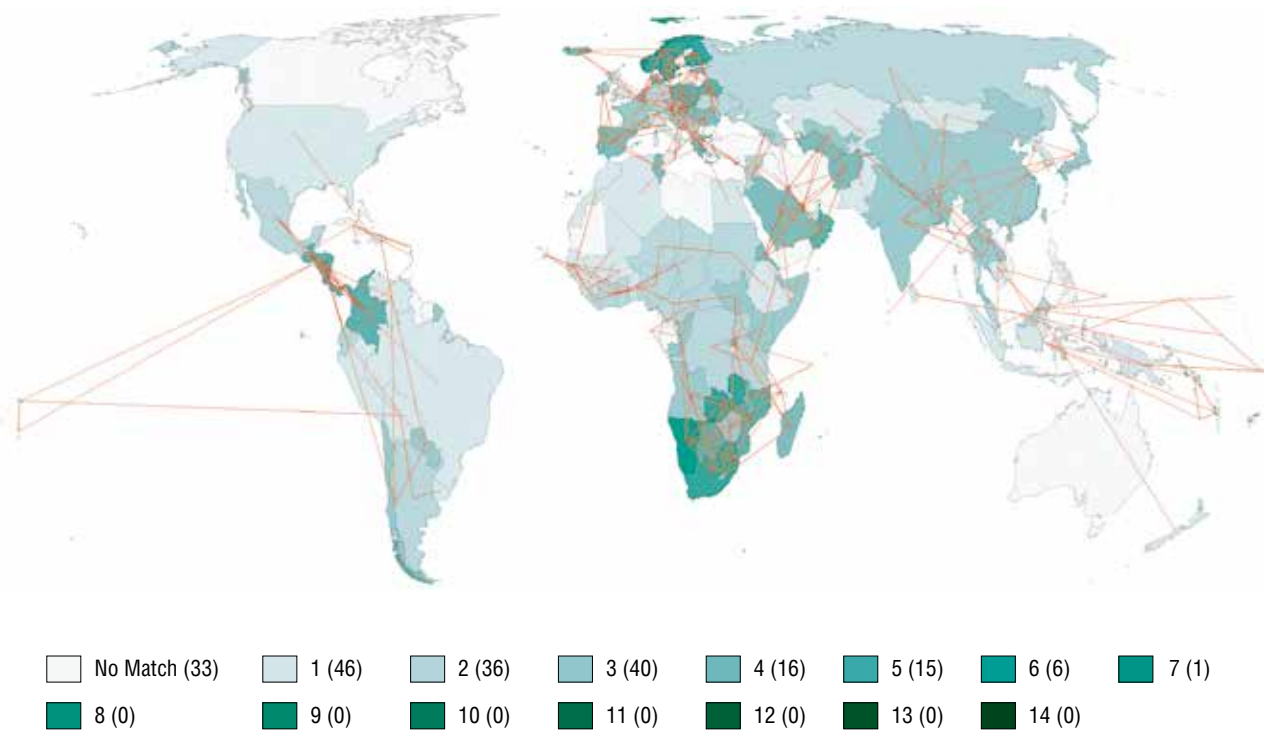


Fig. 6.3.2. Likelihood-ratio test for the “Highly wealthy population” parameter

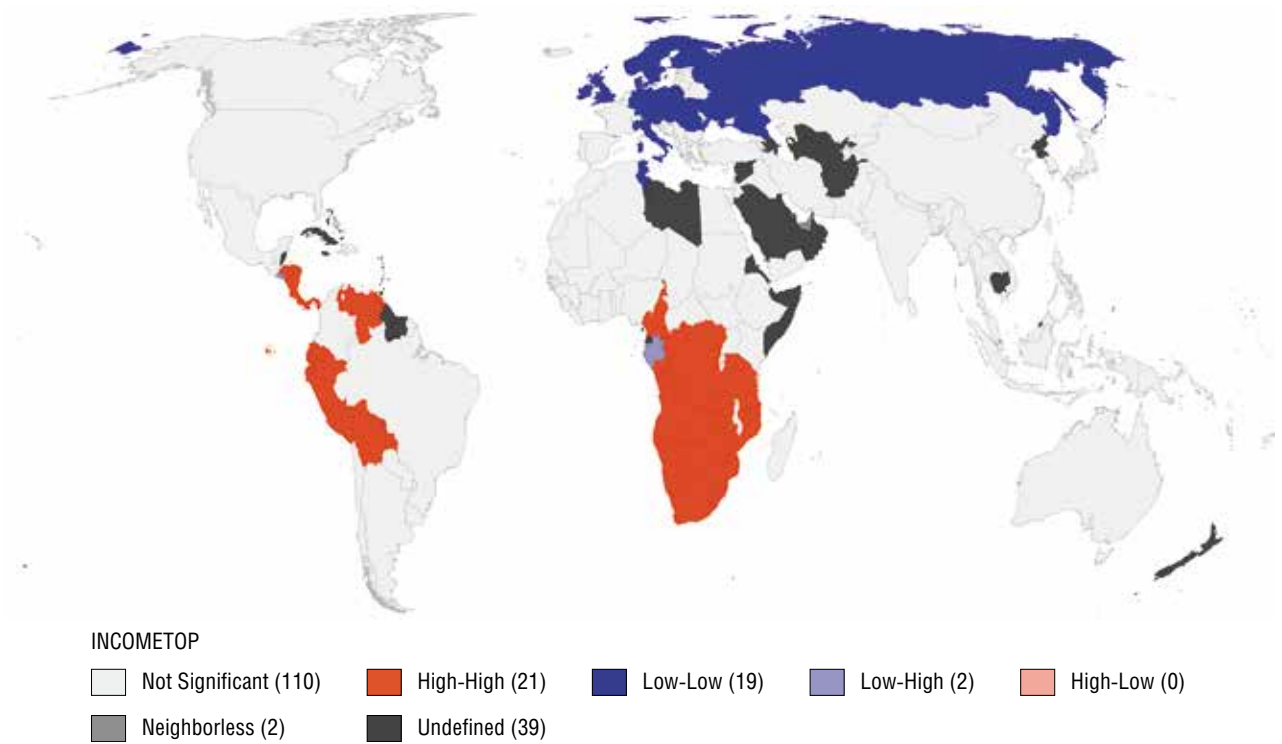


Fig. 6.3.3. “Highly wealthy population” spatial autocorrelation cartogram for the geometric neighbourhood matrix

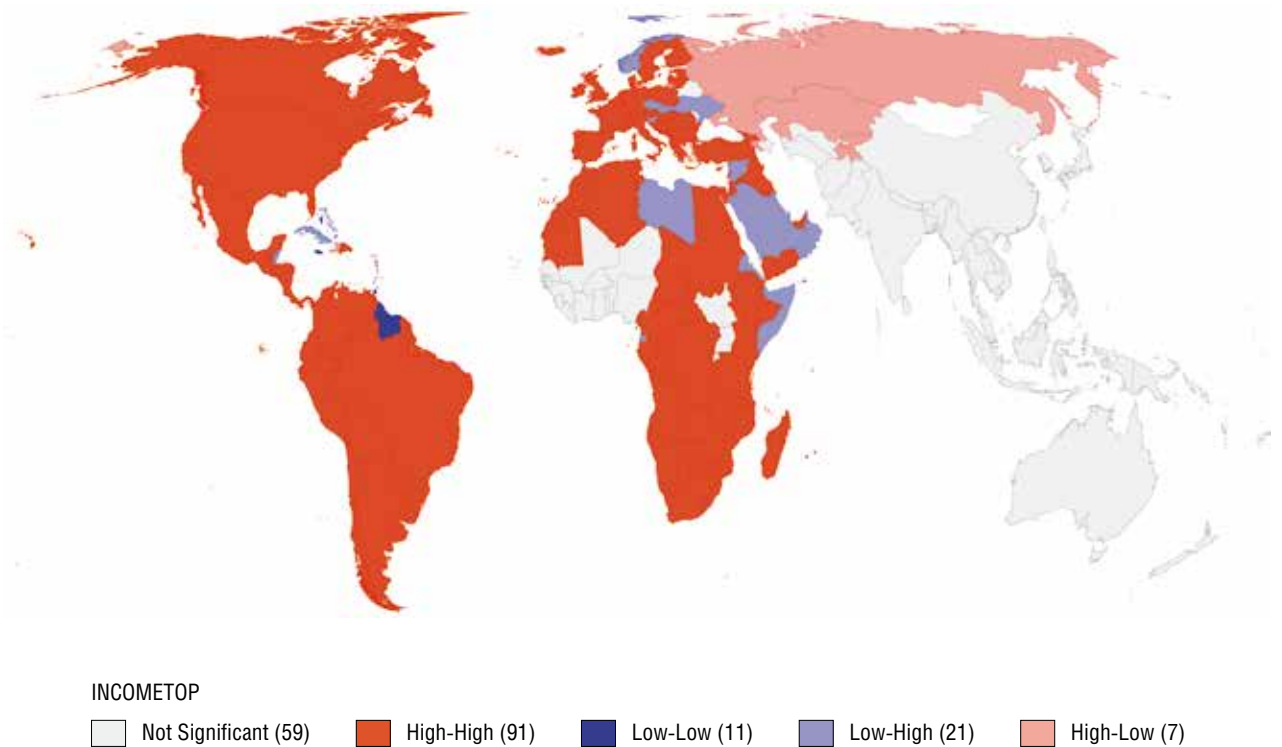


Fig. 6.3.4. “Highly wealthy population” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.4. Unemployment

The World Bank's experts monitor unemployment statistics for the economically active population. Among other things, this indicator measures socioeconomic inequality in a given country in terms of the population's access to jobs and attests to the degree of efficiency in labour resource distribution.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.388	0.000	0.122	0.000
Geary's C	0.609	0.000	0.874	0.000

The percentile cartogram (Fig. 6.4.1) suggests that the highest unemployment rate is recorded in Southern Africa, namely, in South Africa, Namibia and Botswana, and in the north of the continent in Tunisia, Libya and Sudan. Curiously, the lowest unemployment figures are also recorded in an African country (Niger). This phenomenon is presumably related to the socioeconomic policies of Niger's government. Qatar also has low unemployment, which is almost zero. This can be explained by the fact that Qatar is an oil-producing country with a high percentage of migrants in the workforce. The geometric spatial matrix for this indicator yields a greater correlation than the geopolitical one, which attests to insufficient influence of international relations structure on the global unemployment distribution.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 6.4.3) reveals five clusters: three with high unemployment levels and two with low unemployment levels. The first cluster is in Southern Africa, while the second is in the north of Africa (Libya and Egypt), where the unemployment rate is related to the so-called youth bulge and access to jobs is extremely limited. The third high-value cluster stretches from the Balkans to Turkey, with Bulgaria being an exception. These countries also have a young population and an unstable economy. Low-value clusters include a grouping of Southeast Asian countries and the African group of Tanzania and Kenya. These clusters can also be identified from the geopolitical neighbourhood matrix.

The geopolitical neighbourhood matrix cartogram (Fig. 6.4.4) also identifies three spatial clusters. One, a North African cluster, is characterized by high levels of unemployment. Somalia, Iraq and Syria may also

Global place	Country	Indicator (%)
1	South Africa	26.92
2	Lesotho	23.97
3	Swaziland	22.36
Mean (65–66)	Suriname, Portugal	6.99
Median (91)	Bulgaria	5.21
176	Solomon Islands	0.62
177	Niger	0.47
178	Qatar	0.11

be included in this geopolitical bloc. Unemployment is witnessed in Arab countries with low and medium levels of economic development due to the high numbers of skilled and unskilled workers in the 20–40 age group leaving the country. At the same time, Ethiopia, Kenya and Tanzania form a cluster with low values, which means that these are highly dynamic economies on the way to the second type of population reproduction. An Asian cluster with low unemployment figures is emerging in the spatial autocorrelation cartogram for the geometric neighbourhood matrix, while the geopolitical neighbourhood matrix includes a greater number of countries. This may be explained by the active campaign carried out under the auspices of the United Nations and intended to eradicate regional unemployment as part of achieving the Sustainable Development Goals. The largest cluster with low unemployment is located in East and Southeast Asia and also includes China and Japan. This cluster points to the significant role of the neighbourhood factor in the system of international relations, since most countries in the region are united by a common integration group, ASEAN. The geopolitical neighbourhood matrix cartogram also does not have a Southern African cluster. This may suggest a weak geopolitical correlation in this region and insufficient significance of the neighbourhood factor.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Unemployment” parameter (Fig. 6.4.2) confirms our conclusions: a high density of connections is observed in North Africa and in East and Southeast Asia. However, no clustering is observed in Latin America and Western Europe under either the geometric or geopolitical matrices, despite the presence of intensive connections in these regions.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Female labour	0.128	0.379	0.000	1.125
2	Economic inequality	0.037	0.168	0.018	0.762
3	Highly wealthy population	0.049	0.177	0.007	0.646
4	Religious diversity	0.047	–0.162	0.004	0.560
5	Marriage	0.077	–0.183	0.000	0.436
6	Female population	0.027	0.107	0.030	0.432
7	HIV incidence	0.225	0.286	0.000	0.363
8	Cultural solidarity	0.052	0.126	0.004	0.308
9	Tax revenues	0.062	0.125	0.004	0.251
10	Female unemployment	0.826	0.441	0.000	0.235

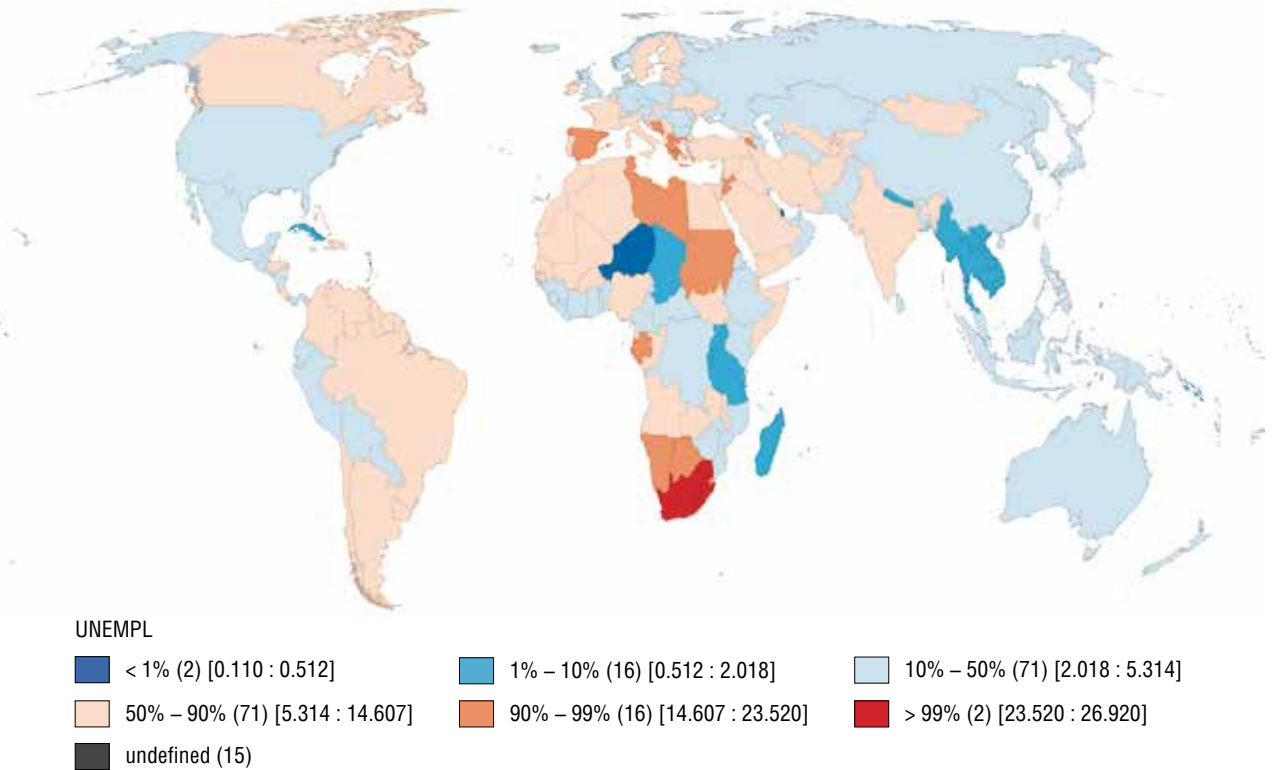


Fig. 6.4.1. Percentile cartogram for the “Unemployment” indicator

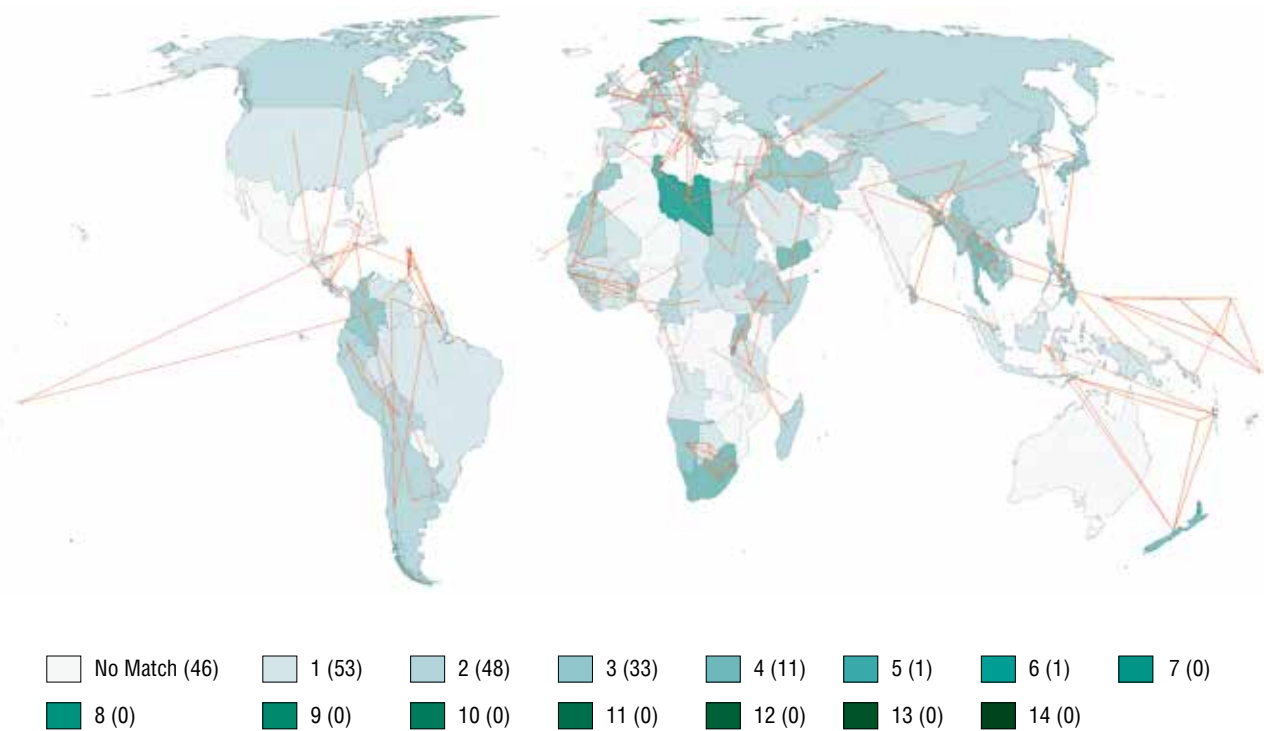


Fig. 6.4.2. Likelihood-ratio test for the “Unemployment” parameter

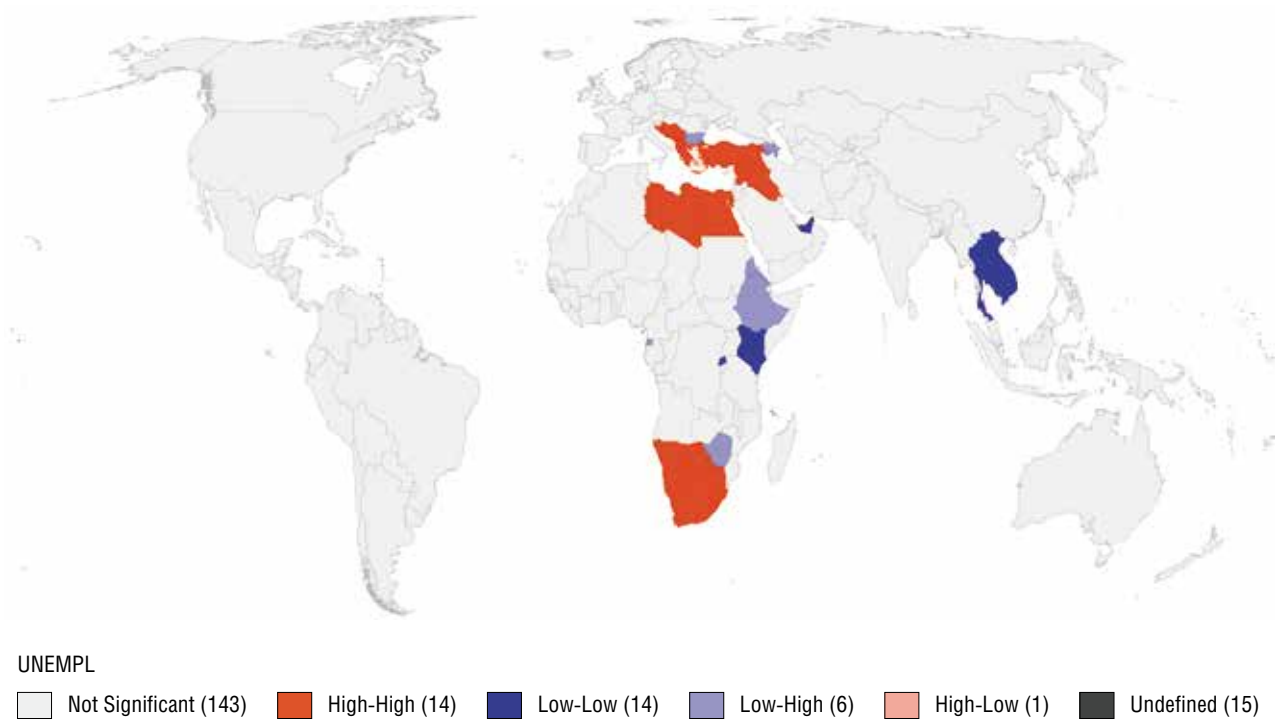


Fig. 6.4.3. “Unemployment” spatial autocorrelation cartogram for the geometric neighbourhood matrix

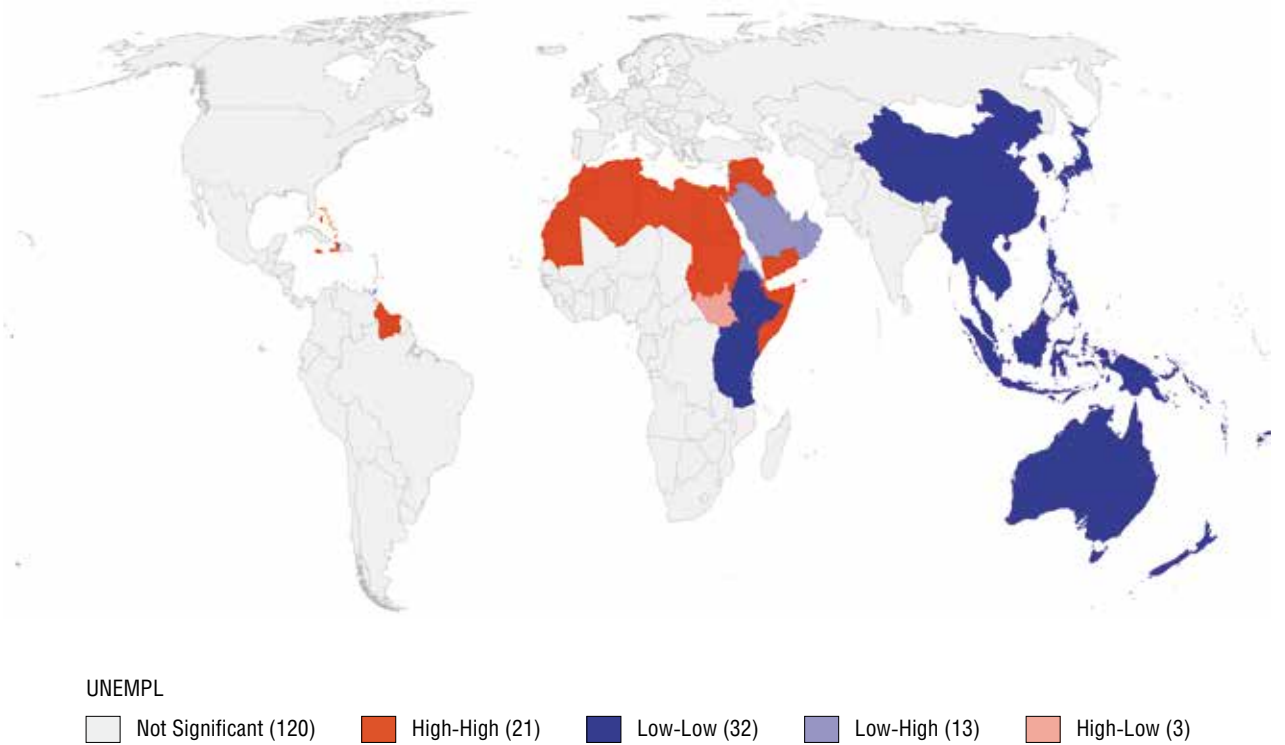


Fig. 6.4.4. “Unemployment” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.5. Female unemployment

The Female unemployment indicator measures the percentage of unemployed women in the economically active female population. This indicator helps assess the equality of opportunities for men and women in terms of access to job markets across the world.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.397	0.000	0.211	0.000
Geary's C	0.621	0.000	0.785	0.000

The percentile cartogram shows that countries with the highest female unemployment are located on the Arabian Peninsula and the north of Africa (Fig. 6.5.1). The lowest female unemployment figures are observed in Southeast Asia. Key factors that unite countries with high levels of unemployment among the female population are religion and ethnocultural considerations. The second group of states with above-mean level of unemployment includes the countries of Northern and Southern Europe and Latin America, which can be explained by the socioeconomic structure of these societies. The percentage of working women in the economically active population depends on per capita income: women in countries with lower economic indicators have greater need to work. This indicator does not confirm the hypothesis that the world's geopolitical structure has greater significance because the geometric neighbourhood matrix yields a greater spatial autocorrelation than the geopolitical matrix.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 6.5.3) shows four clusters: two with high female unemployment (Arab countries of the Arabian Peninsula and North Africa and Southern Africa) and two with low indicator values (part of Eastern and Central Africa and Southeast Asia). However, not all countries from these regions made the first two clusters. Morocco and Algeria are exceptions in North Africa, while Zimbabwe, Mozambique, Zambia, Angola and Malawi are exceptions in Southern Africa. Zimbabwe (despite being an immediate neighbour of two large states in the cluster) can be seen as an "error," since the percentile cartogram shows it among countries with above-mean female

Global place	Country	Indicator (%)
1	Iraq	30.85
2	Sudan	29.13
3	South Africa	29.05
Mean (65)	(Dominican Republic)	8.07 (8.36)
Median (90)	Mongolia	5.59
176	Laos	0.58
177	Qatar	0.48
178	Niger	0.37

unemployment levels. Religious and ethnocultural factors are the source of female unemployment in both clusters.

The African cluster with low female unemployment (the Democratic Republic of the Congo, Tanzania and Uganda) is an interesting phenomenon that may be explained by the predominance of Christianity in these countries and, consequently, by the influence of the Western legacy on female labour. Low female unemployment in Southeast Asia is linked with the accelerated build-up of the economic potential of the region's countries, which requires high employment of all employable persons.

Curiously, the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 6.5.4) expands the cluster of low female unemployment rates to include China (i.e. the East Asian region) in the cluster, which attests to the significance of geopolitical neighbourhood, even though the geometric neighbourhood matrix yields greater autocorrelation for this indicator. Two more clusters are located in Africa: the first (spanning the Arabian Peninsula) with high unemployment rates coincides with the previous one (it does not, however, include Mali, Senegal, Ghana and Turkey); the second low-value cluster is located in East Africa. The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix does not feature a cluster of Southern African countries, which suggests that the international relations structure is not particularly significant in the region.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Female unemployment" parameter confirmed the previously identified clusters (Fig. 6.5.2). Dense connections were also identified in the countries of Latin America and the Caribbean. A trend that is characteristic for this region is also seen in the analysis of the percentile cartogram, which shows an above-median female unemployment indicator values for most countries of the region. This fact may be linked to faulty legislation protecting women's rights in the region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Forest areas	0.025	-0.174	0.036	1.211
2	Highly wealthy population	0.029	0.16	0.038	0.887
3	Regional trade agreements	0.023	-0.115	0.045	0.582
4	Religious diversity	0.065	-0.19	0.001	0.555
5	Military spending	0.102	0.228	0.000	0.509
6	Passport power	0.025	-0.105	0.035	0.443
7	Cultural solidarity	0.039	0.13	0.013	0.436
8	Marriage	0.048	-0.142	0.003	0.424
9	Conservation areas	0.028	-0.102	0.027	0.378
10	Healthcare spending	0.023	-0.091	0.049	0.368

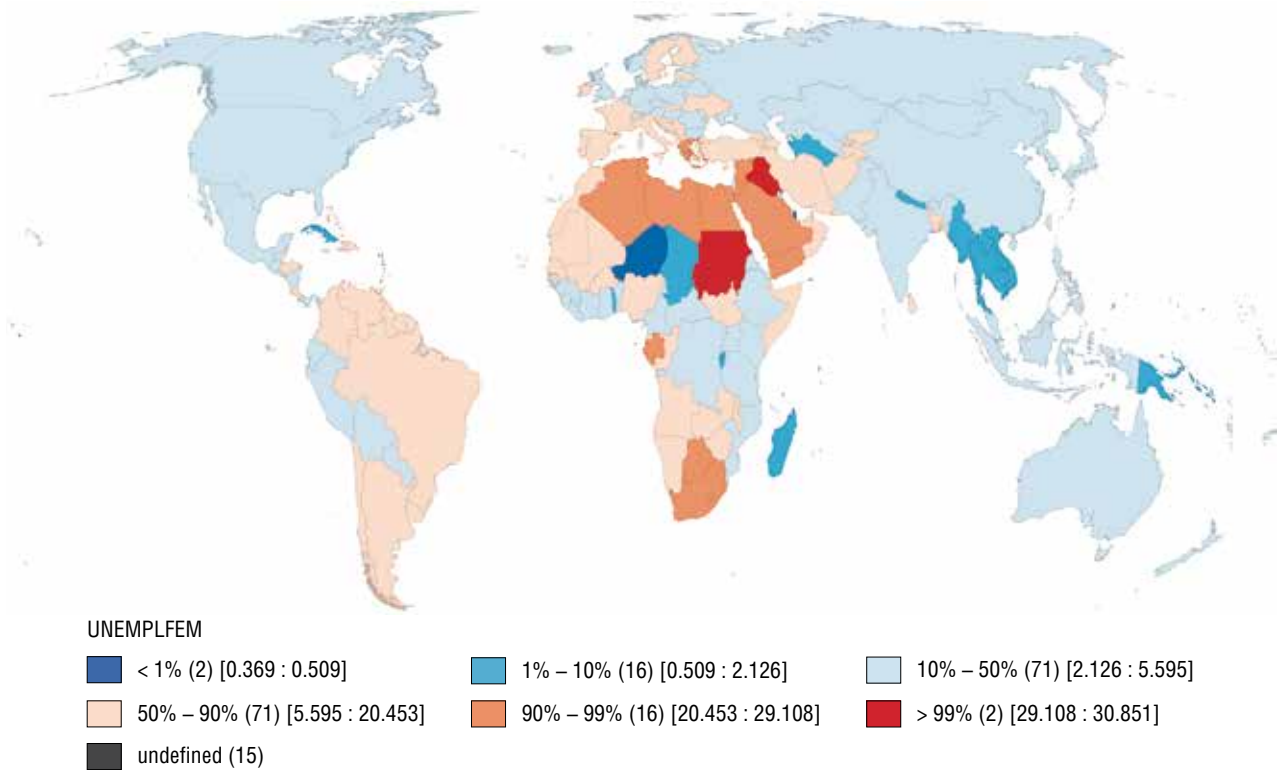


Fig. 6.5.1. Percentile cartogram for the “Female unemployment” indicator

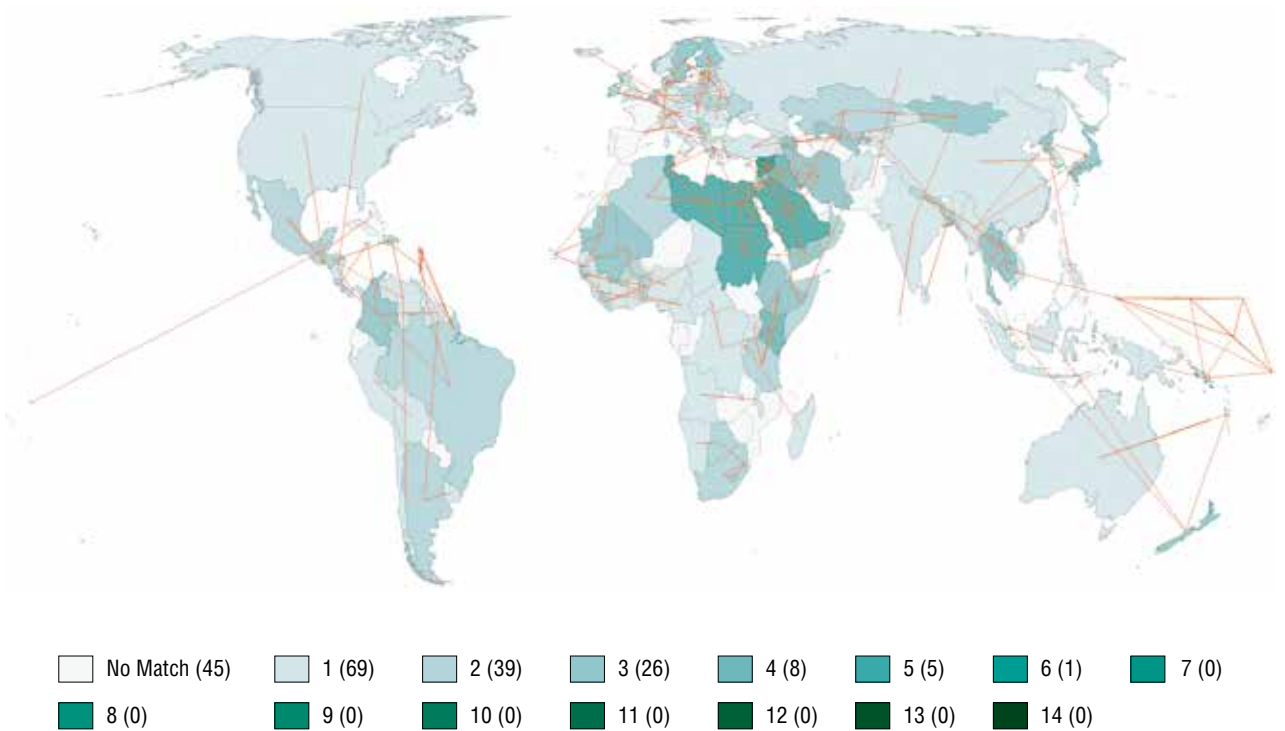


Fig. 6.5.2. Likelihood-ratio test for the “Female unemployment” parameter

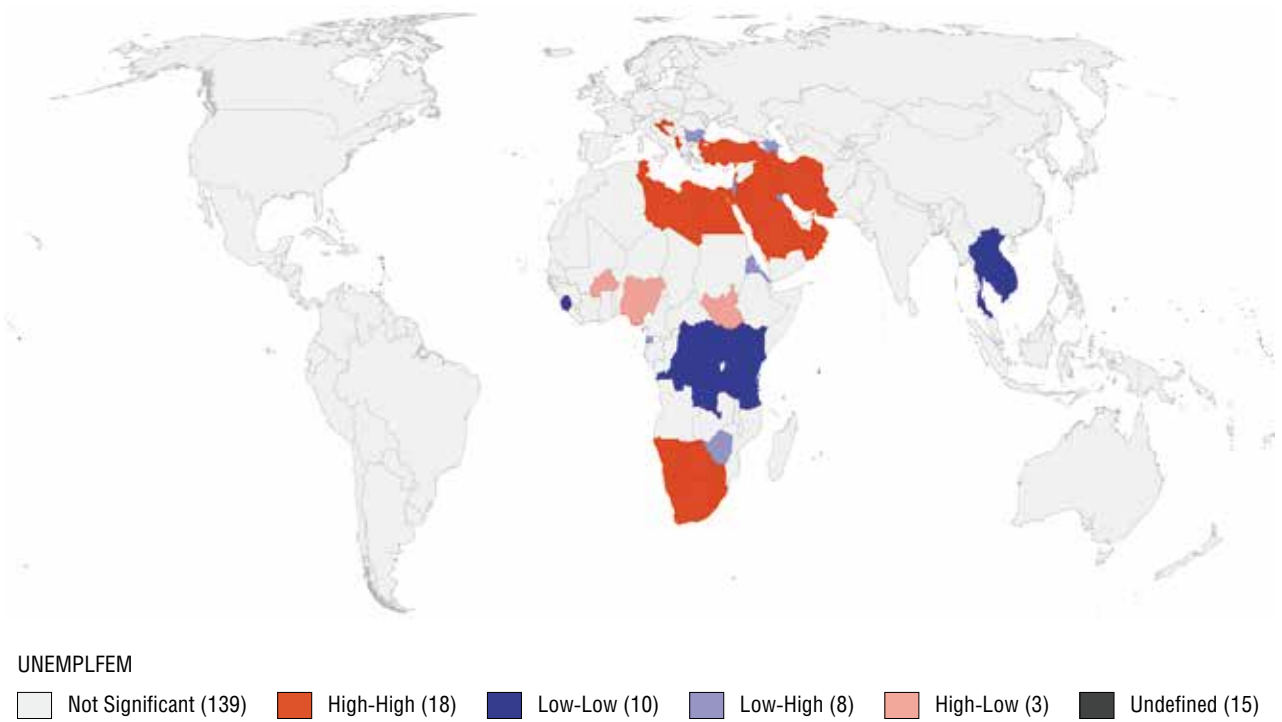


Fig. 6.5.3. “Female unemployment” spatial autocorrelation cartogram for the geometric neighbourhood matrix

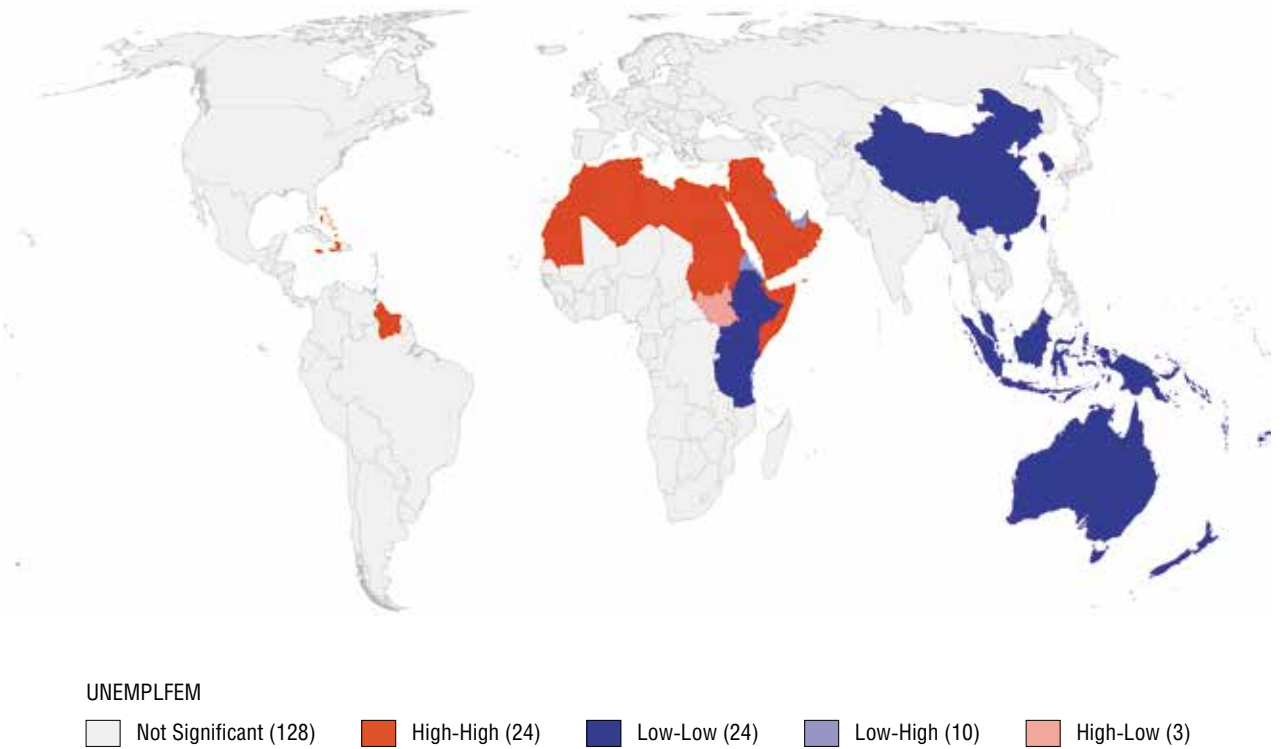


Fig. 6.5.4. “Female unemployment” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.6. Female labour

Female labour is an indicator measuring the percentage of economically active female population aged 15 and older. The percentile cartogram shows that countries with lowest Female labour figures are located in North Africa, the Arabian Peninsula and South Asia. Low numbers of women in employment are also concentrated in Southern Europe; partially, this area extends to Latin America and the Caribbean. The highest Female labour figures are recorded in Southeast Asian countries (Vietnam, Laos, Cambodia) and sub-Saharan Africa (Fig. 6.6.1). The distribution suggests religion as the key factor in low female labour in regard to Arab Muslim countries. High employment in sub-Saharan Africa is due to the low quality of life, which pushes women to join the labour force while poverty remains high.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.404	0.000	0.235	0.000
Geary's C	0.578	0.000	0.761	0.000

While demonstrating a moderately positive relationship, this indicator, nevertheless, does not confirm the hypothesis that the geopolitical global structure has greater significance, since the geometric neighbourhood matrix yields greater spatial correlation than the geopolitical matrix.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix identifies three clusters (Fig. 6.6.3): the first comprises Arab countries of North Africa (with the exception of Morocco), the Arabian Peninsula (with the exception of Yemen) and all countries of South Asia (with the exception of Bangladesh and Sri Lanka). The second cluster of high Female labour includes countries from parts of East, Southern and Central Africa. The third cluster is formed by Southeast Asian countries (Vietnam and Cambodia) and also demonstrates high numbers of female employment. The first cluster is based on religious and ethnocultural factors that explain the rigid classification of jobs into "male" and "female." The Islamic tradition of families with many children also stands in the way of high numbers of employed women, since women are charged with raising the children. Southeast Asian countries, in particular Vietnam, demonstrate high

Global place	Country	Indicator (%)
1	Rwanda	83.9
2	Madagascar	83.3
3	Nepal	82.7
Mean (98)	(United Arab Emirates)	52.4 (52.3)
Median (89–90)	Mongolia, Panama	53.4
176	Jordan	14.4
177	Iraq	11.4
178	Yemen	6.0

employment, including Female labour. Vietnam's figures stem from its socialist system, which promotes gender equality. In the case of Cambodia, its figures are also connected with the consequences of Pol Pot's regime, which turned the country into the region's poorest economy. Consequently, Cambodia needs to employ the highest percentages of all population groups, including women.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 6.6.4) shows three clusters: two with low Female labour (the north of Africa and the Arabian Peninsula, and South Asia), and one with high percentage of female involvement in labour force (East Africa without Somalia, Central and Southern Africa, excluding South Africa). The cartogram also distinguishes West African countries (Niger, Burkina Faso, Togo, Guinea and Sierra Leone), which attests to the geopolitical ties that exist in the region. The significance of the geopolitical situation is also observed in South Asia, where India is the key actor. Gender inequality is a significant factor for India, which is reflected not only in the low female employment figures, but also in very low female unemployment figures. Notably, there is no Southeast Asian cluster on the geopolitical neighbourhood matrix cartogram. This may be due to the different economic structures in the region's countries and, consequently, the low significance of the international relations structure to it.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Female labour" parameter confirmed the presence of all previously identified clusters (Fig. 6.6.2). Despite dense connections, clustering, however, was not identified in Europe and Latin America. At the same time, the percentile cartogram demonstrates certain trends in these regions.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Life expectancy	0.027	0.026	-0.2	1.44
2	Urbanization	0.024	0.035	-0.171	1.174
3	Tuberculosis morbidity	0.056	0.001	0.239	1.002
4	Military spending	0.105	0	-0.32	0.967
5	Forest areas	0.076	0	0.255	0.845
6	Maternal mortality	0.048	0.003	0.184	0.701
7	HIV incidence	0.047	0.015	0.178	0.666
8	Highly wealthy population	0.047	0.007	0.176	0.652
9	Conservation areas	0.061	0	0.183	0.547
10	Access to electricity	0.135	0	-0.27	0.536

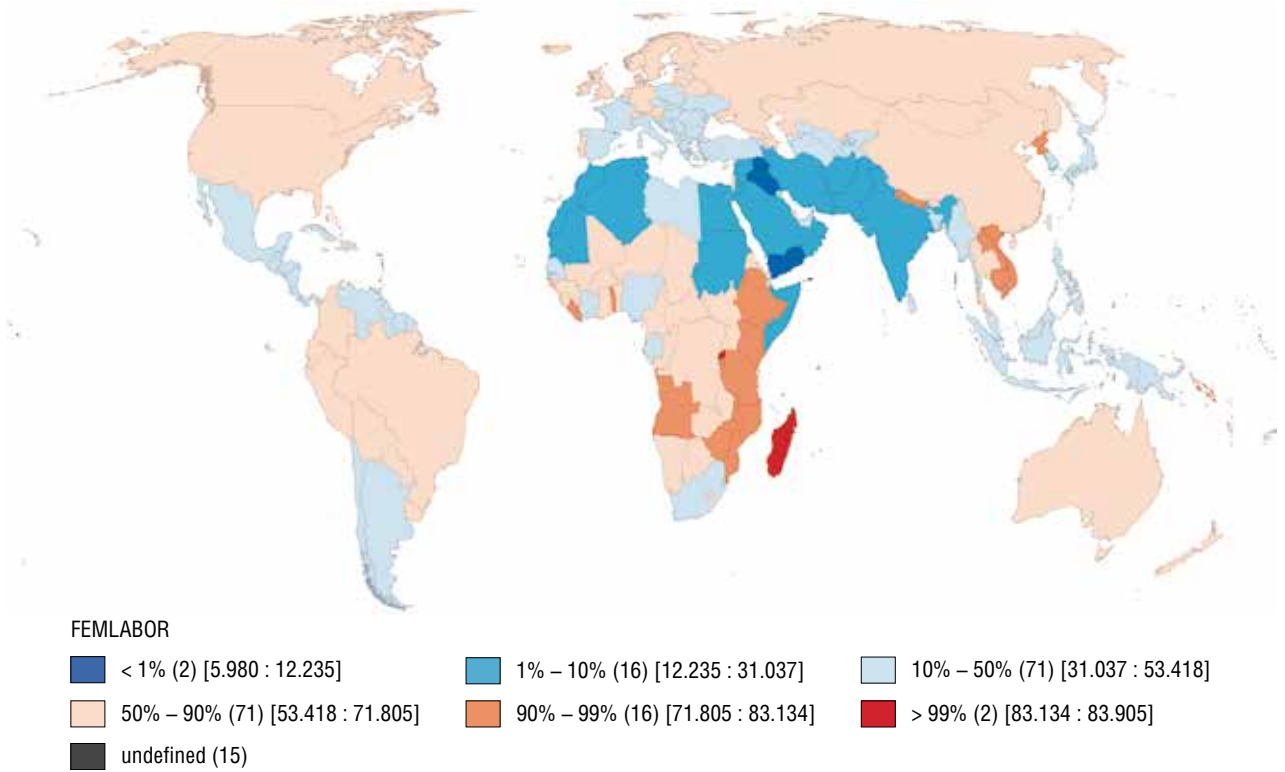


Fig. 6.6.1. Percentile cartogram for the “Female labour” indicator

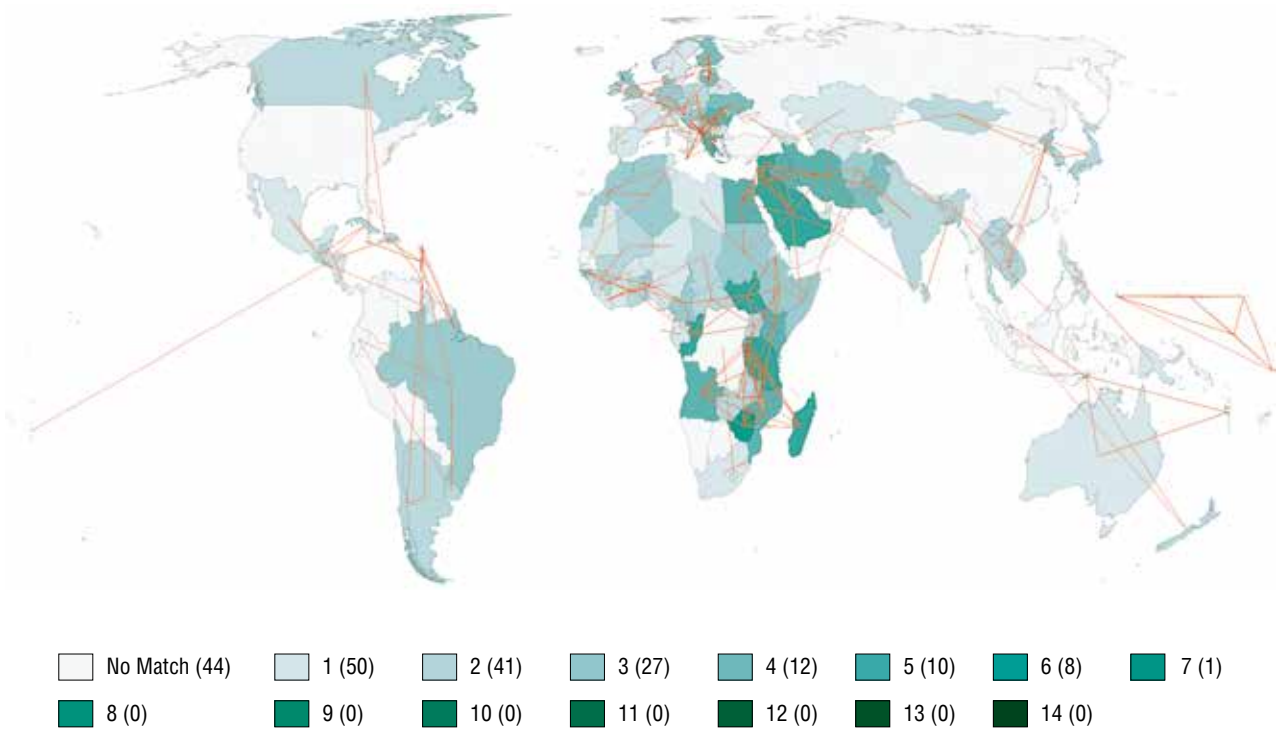


Fig. 6.6.2. Likelihood-ratio test for the “Female labour” parameter

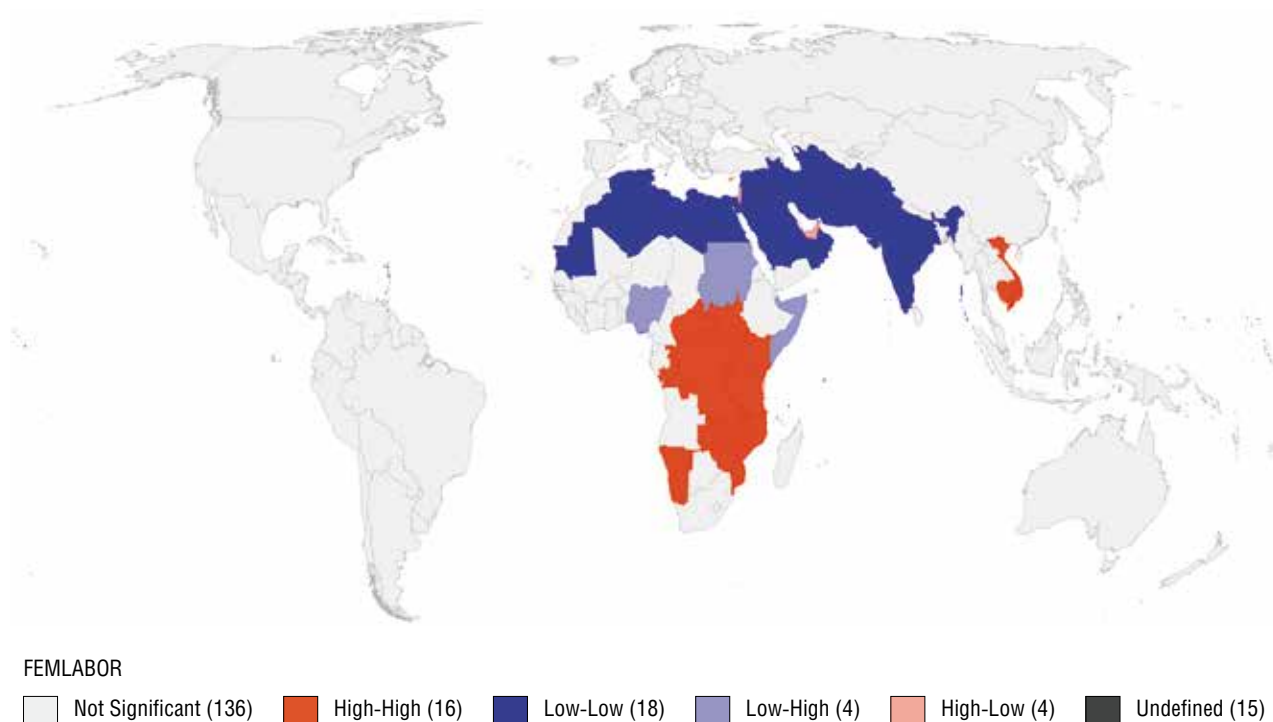


Fig. 6.6.3. “Female labour” spatial autocorrelation cartogram for the geometric neighbourhood matrix

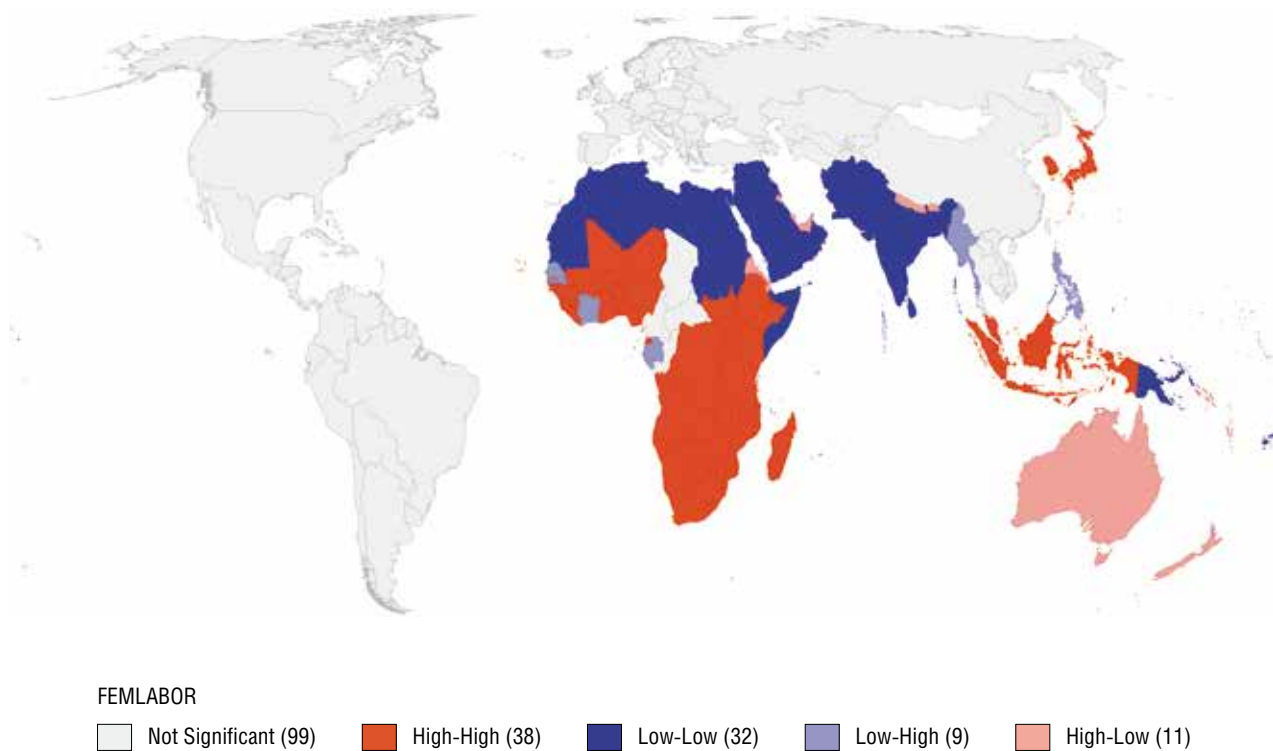


Fig. 6.6.4. “Female labour” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.7. Maternal mortality

Maternal mortality is an important indicator for assessing both reproductive health and the state of perinatal medicine in a given country. This indicator is calculated as the number of women dying from causes related to pregnancy, during pregnancy, or within 42 days of giving birth per 100,000 live births.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.624	0.000	0.528	0.000
Geary's C	0.362	0.000	0.470	0.000

The percentile cartogram (Fig. 6.7.1) shows that countries with high maternal mortality are concentrated in Central Africa (with Chad and South Sudan as the leaders), as well as in Asia, with Afghanistan demonstrating the direst situation. Therefore, we may say that high maternal mortality is typical for the least developed economies with predominantly Muslim populations. The lowest indicator values are recorded in Northern and Southern Europe. Maternal mortality in South America demonstrates above-mean values, and it is only in the south of the continent, specifically, in Chile, Argentina and Uruguay, where the situation with perinatal medicine is better. There is a moderately positive spatial autocorrelation, with the geometric matrix yielding higher values than the geopolitical matrix, which refutes the hypothesis that the global geopolitical structure has greater significance.

Spatial autocorrelation cartograms for the geometric and geopolitical matrices significantly differ from each other. However, both demonstrate a North–South divide.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix shows two clusters: an African cluster of high values that does not include Middle Eastern countries, and Angola, Namibia, Botswana and Zimbabwe in the south (Fig. 6.7.3). The demographic situation in the states within this cluster classifies them as countries with the first type of population reproduction where high population growth is offset by high mortality, including infant and maternal mortality, while healthcare development and financ-

Global place	Country	Indicator (points)
1	South Sudan	1,150
2	Chad	1,140
3	Sierra Leone	1,120
Mean (54)	(Cambodia)	160 (161)
Median (92–93)	Seychelles, Maldives	53
172–174	Sweden, Denmark, Spain	4
175–178	Israel, Finland, Czech Republic, United Arab Emirates	3
179–183	Belarus, Norway, Poland, Italy	2

ing levels are not high for absolute preservation of life and health of mothers and newborns. Additionally, this cluster includes two countries that deviate from the spatial logic, namely, South Africa, which is logical due to its economic development, and Algeria.

The second cluster is located in Eurasia and stretches from Iceland to Russia. The countries in this cluster are dominated by the second type of population reproduction. We should note that this cluster does not include such Southern European states as Spain, Portugal and Greece, which the percentile cartogram shows as countries with low maternal mortality. Additionally, this cluster notably does not include the countries along the Belarus–Bulgaria line, where the level of medical care is comparable to that of the countries in the cluster (Russia, Slovenia, Latvia, the Czech Republic). Consequently, for this indicator, spatial autocorrelation as an instrument does not have sufficient explanatory power for Eastern European cases. The absence of “errors” (“high-low” cases) evidences spatial homogeneity for this indicator.

The geopolitical neighbourhood matrix cartogram demonstrates a similar overall pattern: statistically insignificant autocorrelation in Asia and the Middle East, and two dominant clusters with centres in Africa and Europe. However, their composition is slightly different (Fig. 6.7.4). The European cluster is no longer “Eurasian,” but “Euro-Atlantic”: since Russia is a member of another cohort, it is no longer part of the cluster, but added to it now are the United States and Canada, whose geographic situation prevented them from making the first geometrically conditioned cluster. Additionally, Ukraine, Turkey and Southern European countries are now parts of the cluster, which partially confirms the hypothesis that similar countries strive to develop integration processes. This, at least, is true for the level of healthcare development.

In both cases, no clusters emerge in South America, even though the percentile cartogram would allow us to assume that clusters would emerge between the north and south of the continent.

The findings of a likelihood-ratio test for geometric and geopolitical neighbourhood for the “Maternal mortality” parameter are consistent with results presented above. However, in Latin America and the Caribbean, we observe a significant density of connections between countries with similar maternal mortality indicator values, although that density remains unconfirmed by spatial autocorrelation (Fig. 6.7.2).

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Suicide mortality	0.024	0.044	−0.181	1.346
2	Light pollution	0.023	0.041	−0.167	1.187
3	IMF voting power	0.031	0.017	−0.192	1.177
4	Female labour	0.048	0.003	0.218	0.984
5	Population growth	0.23	0	0.466	0.942
6	Unused export potential	0.032	0.014	−0.171	0.897
7	Highly wealthy population	0.09	0	0.281	0.869
8	Linguistic diversity	0.198	0	0.411	0.852
9	Economic inequality	0.076	0	0.253	0.842
10	Regional trade agreements	0.173	0	−0.372	0.796

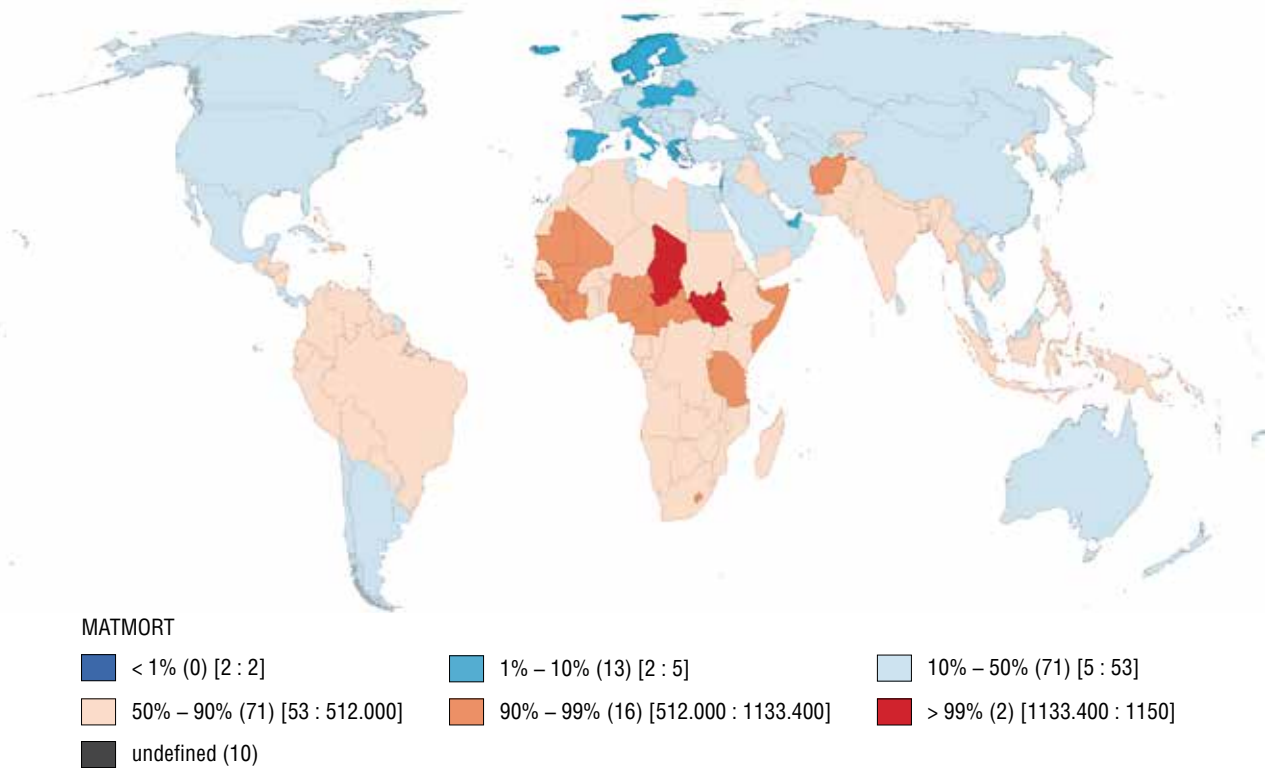


Fig. 6.7.1. Percentile cartogram for the “Maternal mortality” indicator

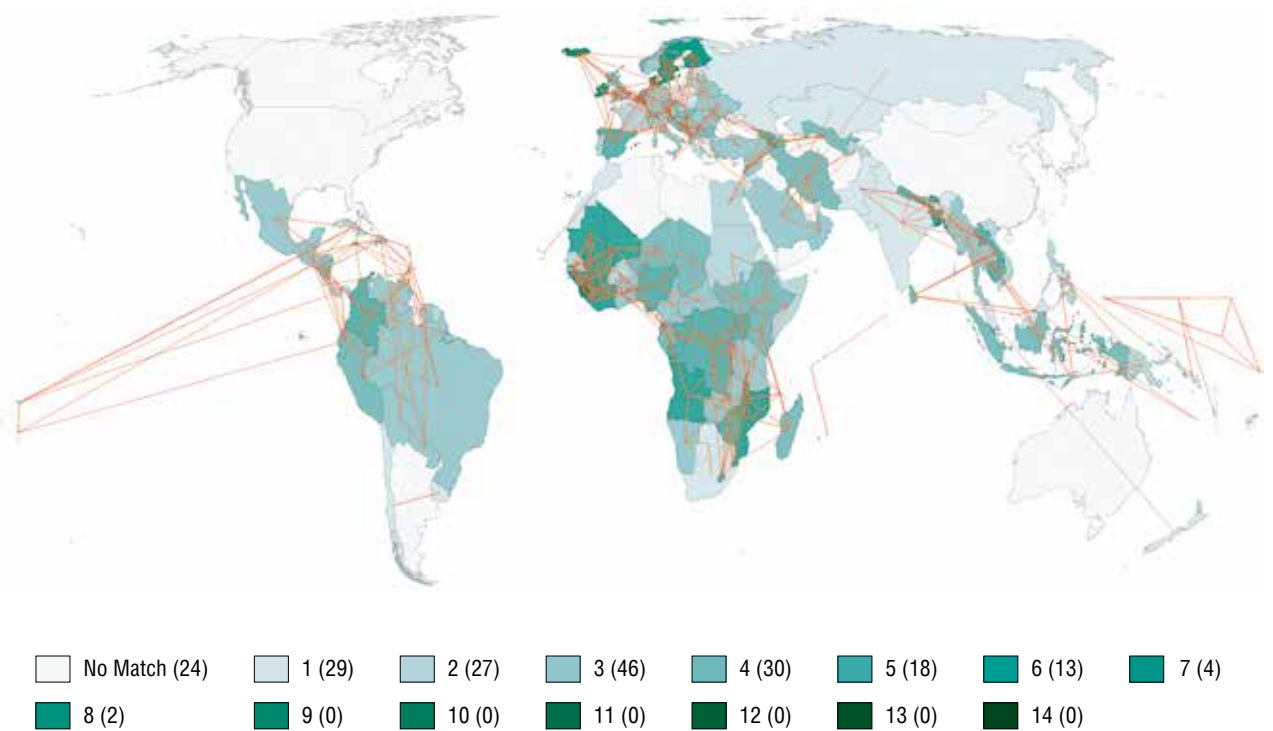


Fig. 6.7.2. Likelihood-ratio test for the “Maternal mortality”

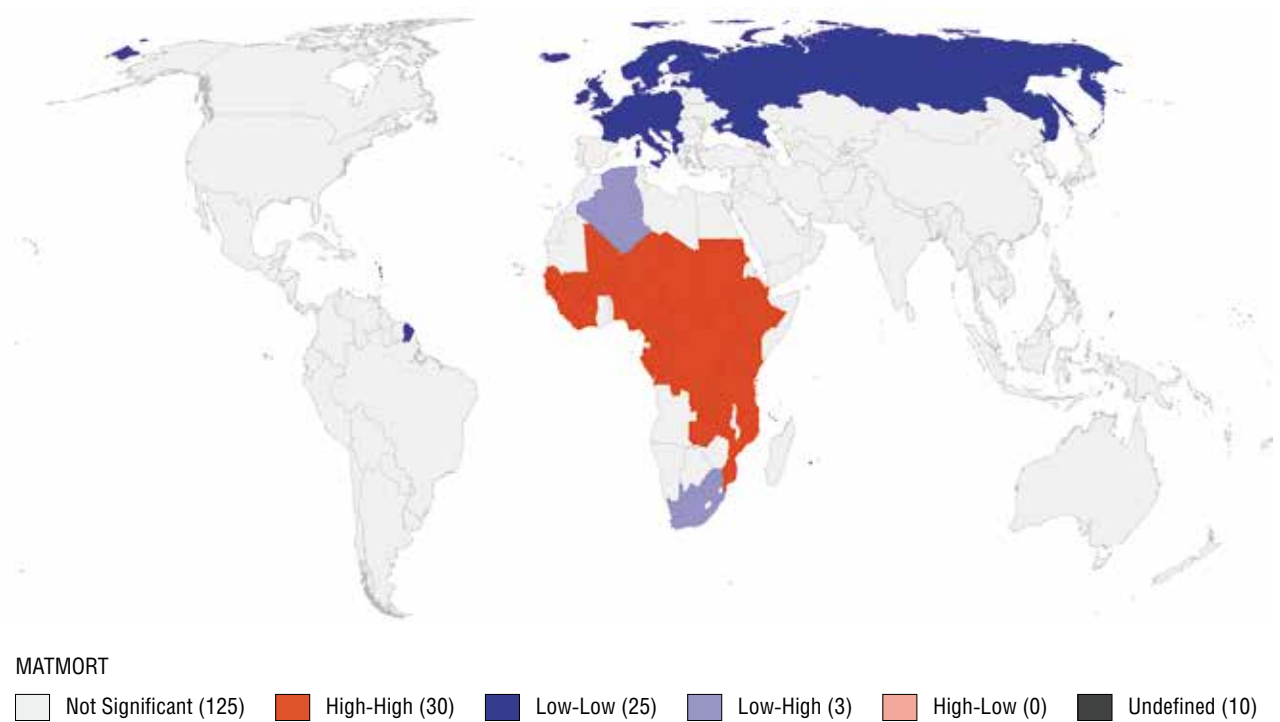


Fig. 6.7.3. “Maternal mortality” spatial autocorrelation cartogram for the geometric neighbourhood matrix

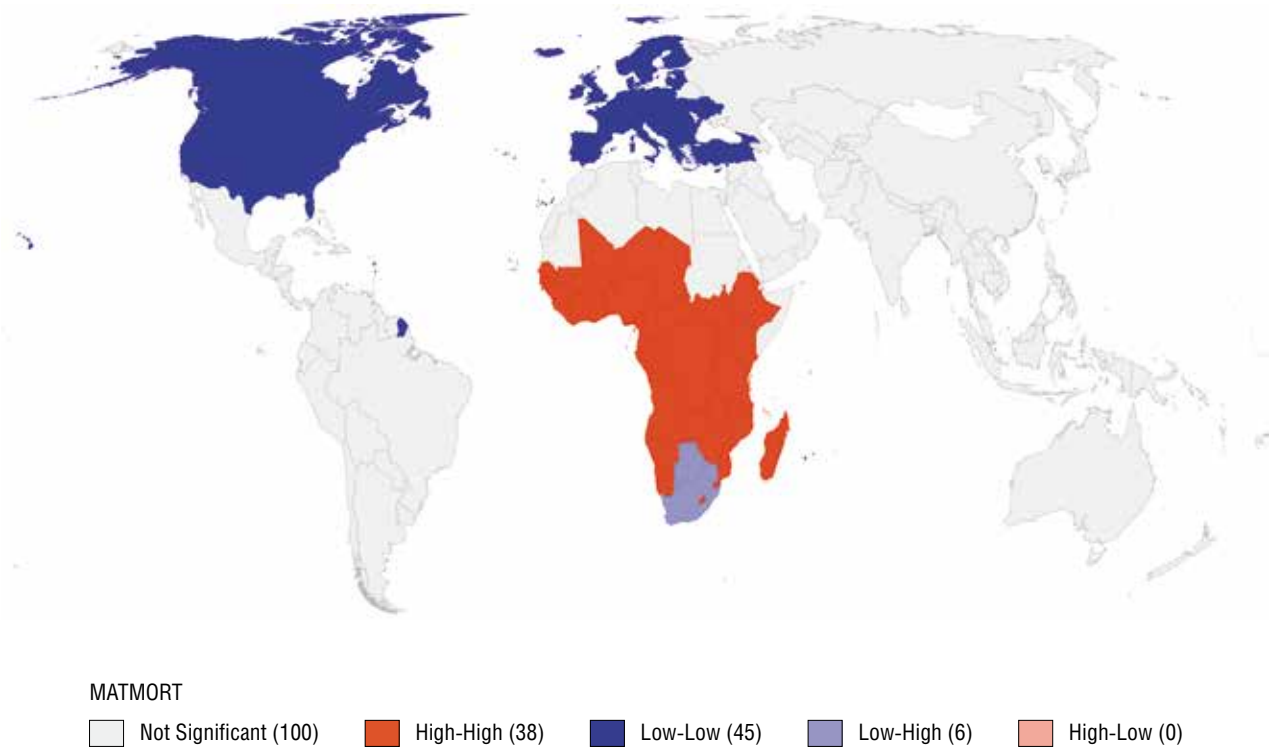


Fig. 6.7.4. “Maternal mortality” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.8. Gender parity at school

The gender parity index for primary and secondary education is calculated as the ratio of girls to boys at public and private primary and secondary schools.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.090	0.024	0.069	0.008
Geary's C	0.887	0.011	0.926	0.008

The percentile cartogram shows (Fig. 6.8.1) that countries with the highest values are scattered across the world without clear geographic regional ties. The gender parity leaders are located in Europe (Belgium and Sweden). High values are also demonstrated by India and Nepal in Asia, Lesotho in Africa, and Suriname in South America. Gender equality in schools is complicated in Africa. Afghanistan and Pakistan lead the way among Asian countries in terms of gender inequality in schools, which is consistent with restrictions for women in these countries. Notably, the hypothesis that developed countries demonstrate higher scores is not fully confirmed: such states as Germany and Italy belong in the 10–50% percentile, while developing economies, for instance, China, India and Tanzania, demonstrate above-mean index values. The spatial correlation for this indicator approaches zero for both matrices, which evidences low spatial factor influence on gender aspects in children's education.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 6.8.3) shows a single cluster with low gender parity index values for primary and secondary school education. This cluster is located in North Africa and potentially could have been larger if we had access to data on other African countries. The cluster includes Burkina Faso, Cameroon, Côte d'Ivoire, Mali, Niger, Sudan, Chad and Ethiopia. On the one hand, clustering is logical for these states as poor economies, yet, on the other hand, we should note that the statistical monitoring of this indicator tells us that these countries are aware of the problem of gender inequality at school and that local governments may be trying to improve the situation.

Global place	Country	Indicator (points)
1	Suriname	1.13
2	Sweden	1.09
3	Belgium	1.08
Median (65)	Moldova	1.00
Mean (90)	Cuba	0.98
127	Chad	0.70
128	South Sudan	0.69
129	Afghanistan	0.64

The geopolitical neighbourhood matrix cartogram shows two spatial clusters (Fig. 6.8.4). The first is the African cluster, which shrank after losing Ethiopia, Sudan and Chad. Countries that remain in the cluster are members of the UEMOA–ECOWAS, but this does not reflect the real influence of the geopolitical factor due, among other things, to low spatial autocorrelation index values for this matrix.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Gender parity at school” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram (Fig. 6.8.2) clearly shows a high density of connections between European and between Caribbean countries, yet no clusters have emerged yet, which once again confirms insignificant connection between gender parity/disparity in school and its geographic worldwide distribution.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Healthcare spending	0.035	0.034	0.214	1.301
2	Regional trade agreements	0.038	0.026	0.197	1.005
3	Population growth	0.072	0.002	−0.266	0.976
4	Elderly population	0.073	0.002	0.262	0.932
5	Publication activity	0.036	0.029	0.18	0.875
6	Availability of electricity	0.038	0.026	0.181	0.852
7	Passport power	0.152	0	0.356	0.830
8	Access to electricity	0.211	0	0.417	0.823
9	Marriage	0.097	0	−0.28	0.805
10	Years at school	0.197	0	0.393	0.780

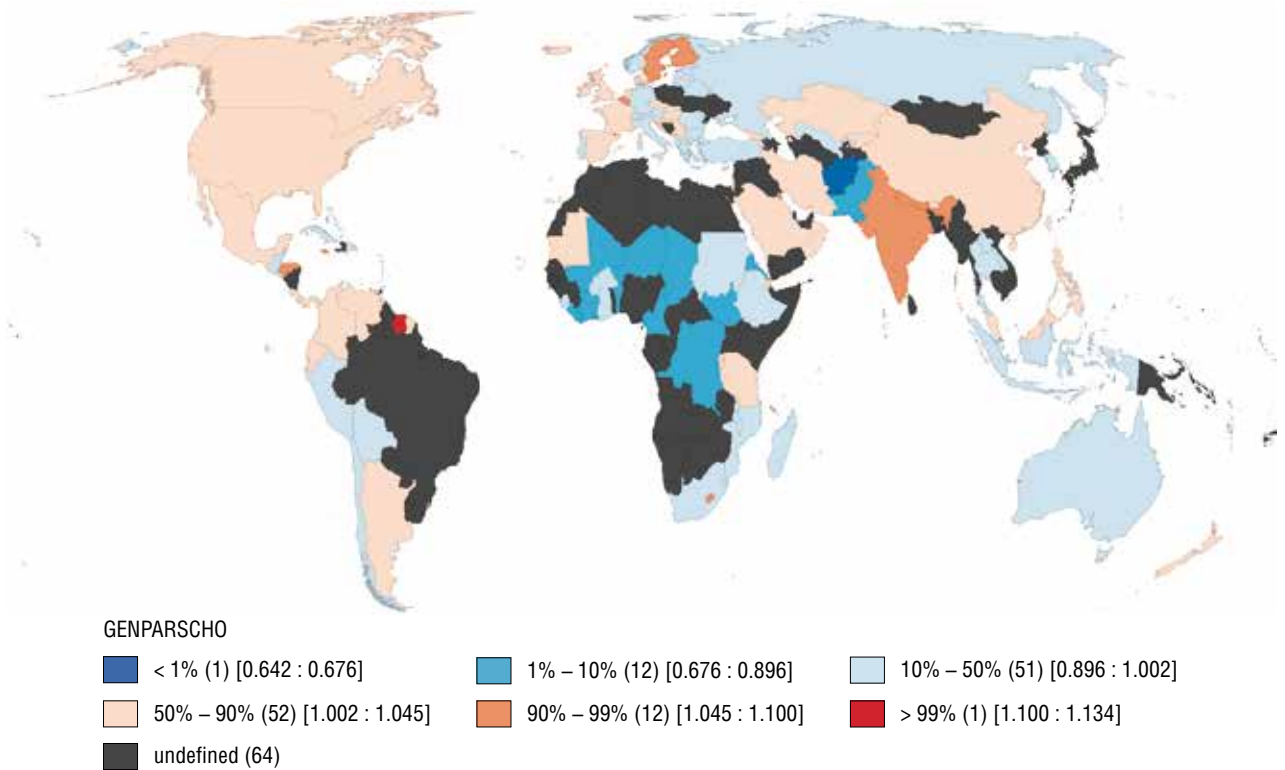


Fig. 6.8.1. Percentile cartogram for the “Gender parity at school” indicator

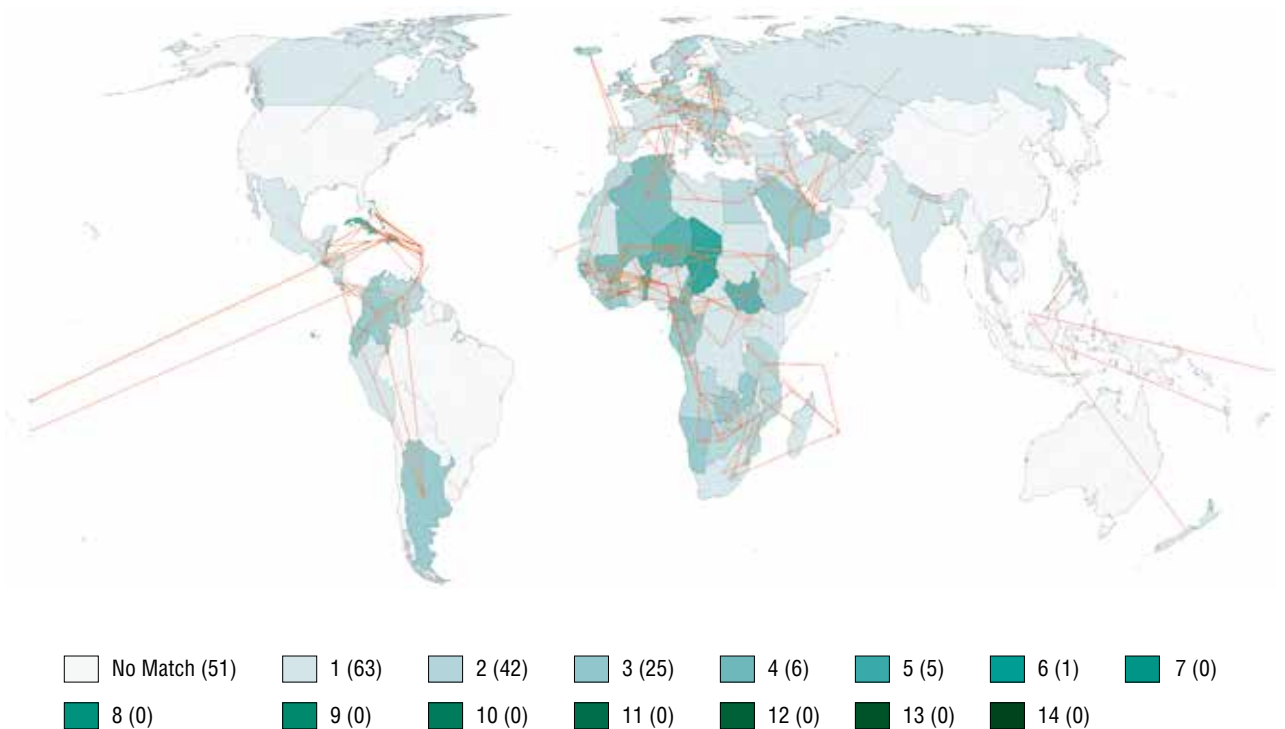


Fig. 6.8.2. Likelihood-ratio test for the “Gender parity at school” parameter

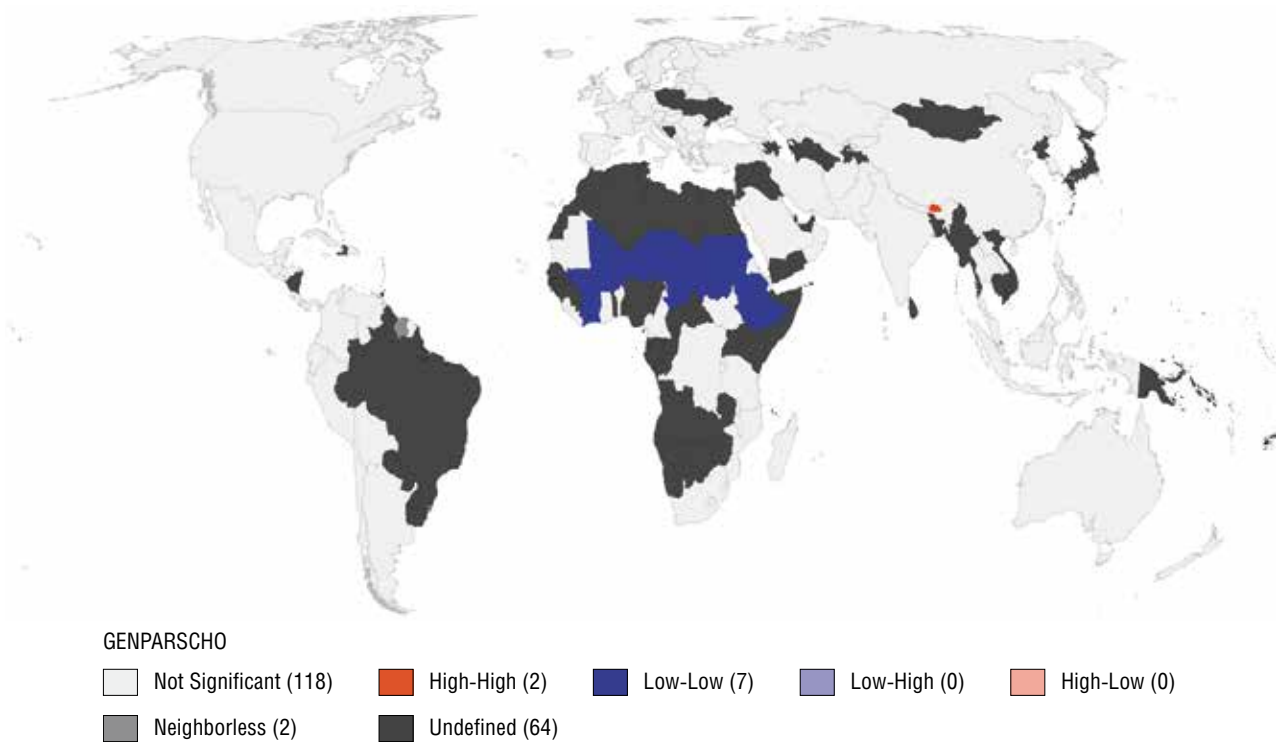


Fig. 6.8.3. “Gender parity at school” spatial autocorrelation cartogram for the geometric neighbourhood matrix

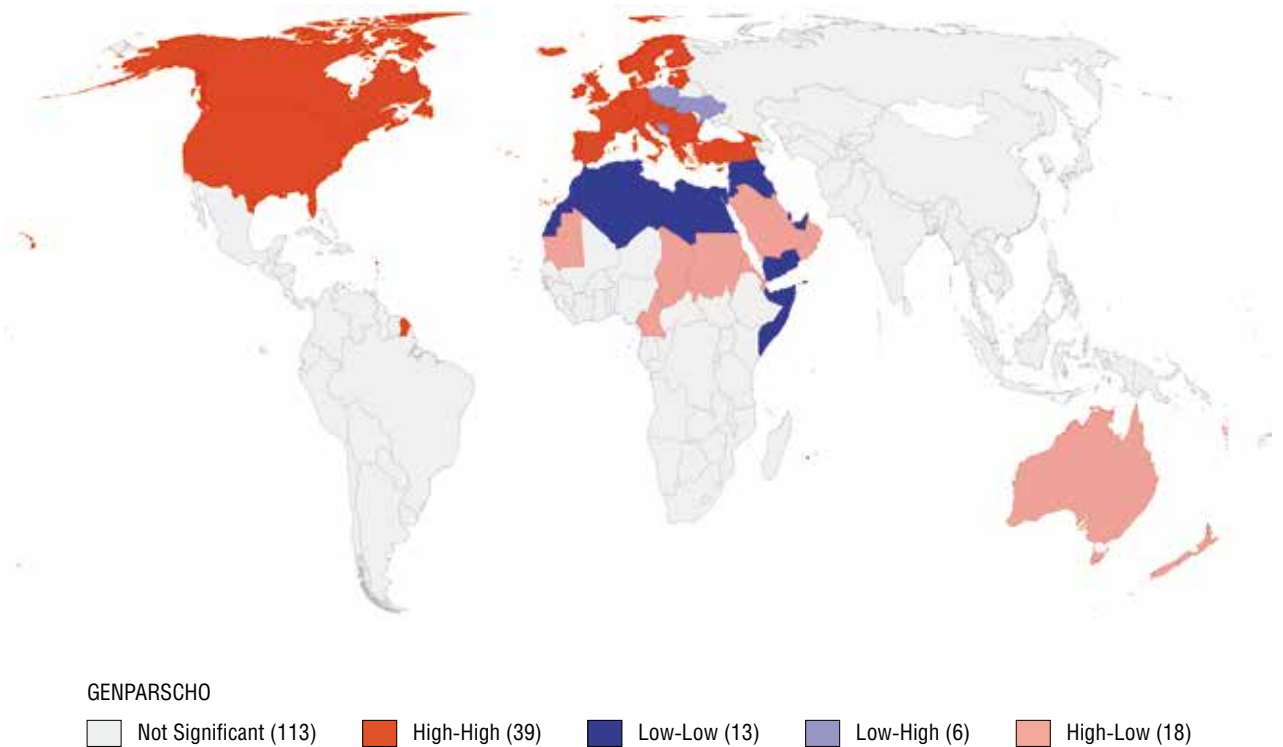


Fig. 6.8.4. “Gender parity at school” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.9. Hospital beds

Hospital beds per 10,000 population tells us not only about the state of a country's healthcare system, but also about how equal or unequal access to medical services is in the country.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.537	0.000	0.399	0.000
Geary's C	0.503	0.000	0.598	0.000

The percentile cartogram shows that, in addition to those countries in Africa and Central Asia for which no data is available, the world is split along the North–South line, with Japan, Europe and North America having high numbers of hospital beds, while Africa, South Asia and Latin America having fewer beds (Fig. 6.9.1). Notably, the United Kingdom, Canada, Sweden and China do not fit into the proposed scheme. The causes are far from obvious, but we can suppose that developed economies shifted the focus of their healthcare not only towards the commercialization of medical care, but also from a reactive to a proactive approach, where available methods, including healthy lifestyle campaigns, are used to gear the population towards disease prevention. This indicator demonstrate a moderately positive connection for the geometric neighbourhood matrix, while it is 25% lower for the geopolitical matrix, which refutes the hypothesis that international relations have greater significance for the advancement of healthcare equality.

The spatial autocorrelation cartogram for the geometric matrix (Fig. 6.9.3) identified three clusters: two with high indicator values, namely, the countries of Central and Eastern Europe; and an Asian cluster (China, Japan, Mongolia). We may assume that this cluster includes countries with a socialist past, when the goals of making healthcare accessible had been set, but Japan does not fit into this logic. Additionally, it fails the geopolitical neighbourhood matrix test, which may partially be connected with insufficient data for several states. For instance, Russia found itself in “isolation” because there is no data for its neighbours, which are members of the CSTO–EAEU–CIS integration groups.

Global place	Country	Indicator (units)
1	Japan	131.7
2	North Korea	116.1
3	Russia	83.5
Mean (42)	(Italy)	32.4 (32)
Median (52)	New Zealand	27.2
102	Guatemala	5.8
103	Afghanistan	5.0
104	Niger	3.1

The Bangladesh–India–Pakistan–Afghanistan cluster is among those with low numbers of available hospital beds. In addition to economic causes, we may be dealing with the large denominator effect: the population in these countries is growing too fast, and national healthcare systems cannot keep up with the population's need for medical services.

The cartogram on the geopolitical neighborhood matrix defines the only Euro-Atlantic cluster (Fig. 6.9.4). The CSTO-EAEC-CIS bloc has become a space of exceptions, where Russia has high values and Ukraine and Georgia have low values. In addition, China and Japan are also characterized by a high level of provision with hospital beds in contrast to their neighbors participating in integration associations. Overall, difficulties in explaining the Eurasian cluster confirm low values of the spatial autocorrelation index: geopolitical prerequisites do not explain the worldwide distribution of hospital beds. It is also worth noting that there are no clusters in Latin America (among the MERCOSUR members) or Southeast Asia (ASEAN members).

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Hospital beds” parameter demonstrates high density of connections in Africa between states that do not collect statistics for this indicator, and also in Central and Eastern Europe, which confirms previously obtained results of high spatial autocorrelation between these states (Fig. 6.9.2).

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Ethnic minorities	0.095	0.001	−0.331	1.15
2	Conservation areas	0.072	0.005	0.286	1.127
3	Female population	0.082	0.003	0.283	0.965
4	Forest areas	0.057	0.014	0.229	0.916
5	Petrol prices	0.07	0.008	0.252	0.902
6	Female labour	0.097	0.001	0.294	0.885
7	Bioethical freedom	0.234	0	0.453	0.875
8	Unused export potential	0.041	0.039	0.186	0.842
9	Linguistic diversity	0.069	0.006	−0.236	0.797
10	Population growth	0.237	0	−0.42	0.742

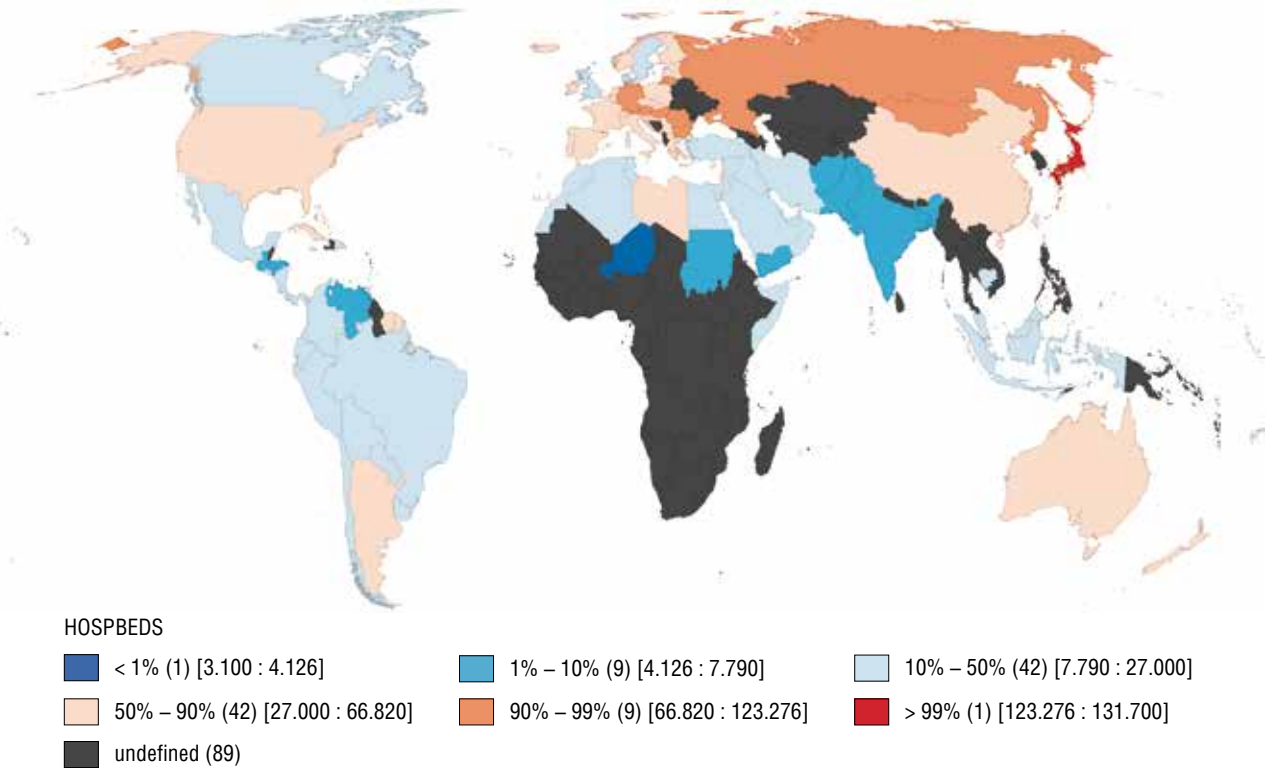


Fig. 6.9.1. Percentile cartogram for the “Hospital beds” indicator

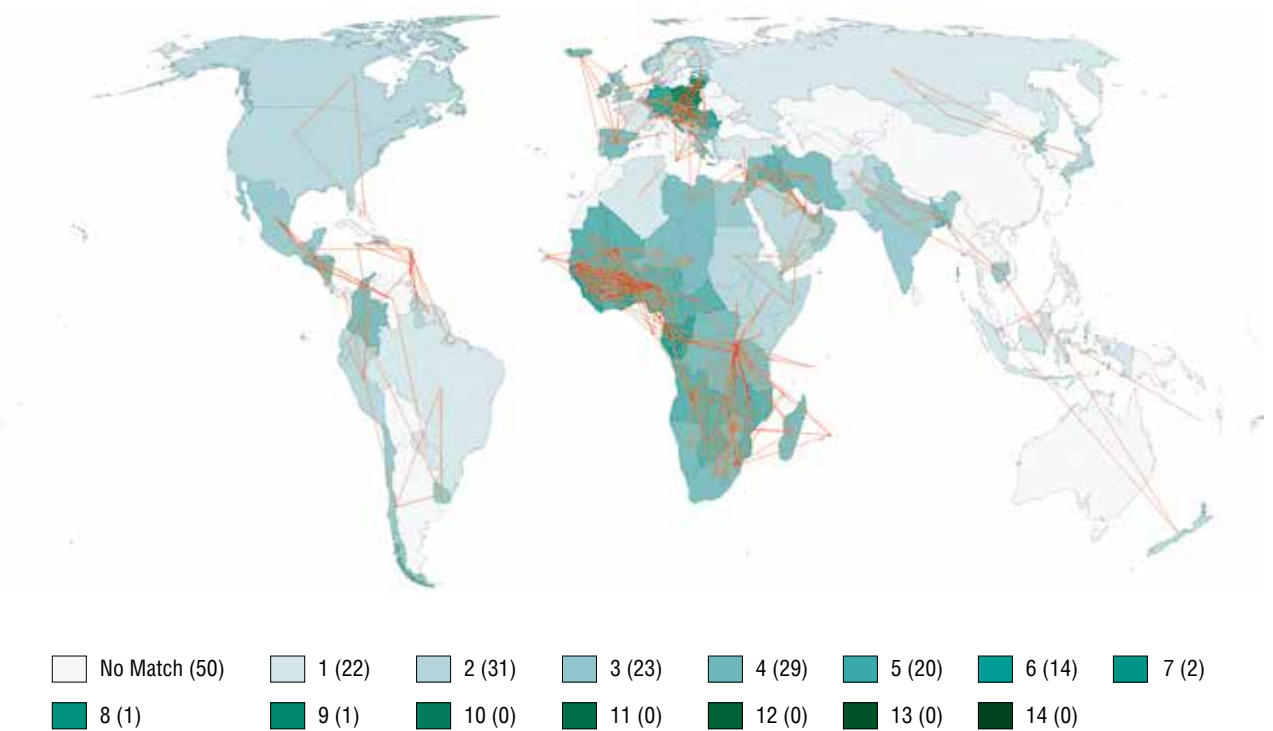


Fig. 6.9.2. Likelihood-ratio test for the “Hospital beds” parameter

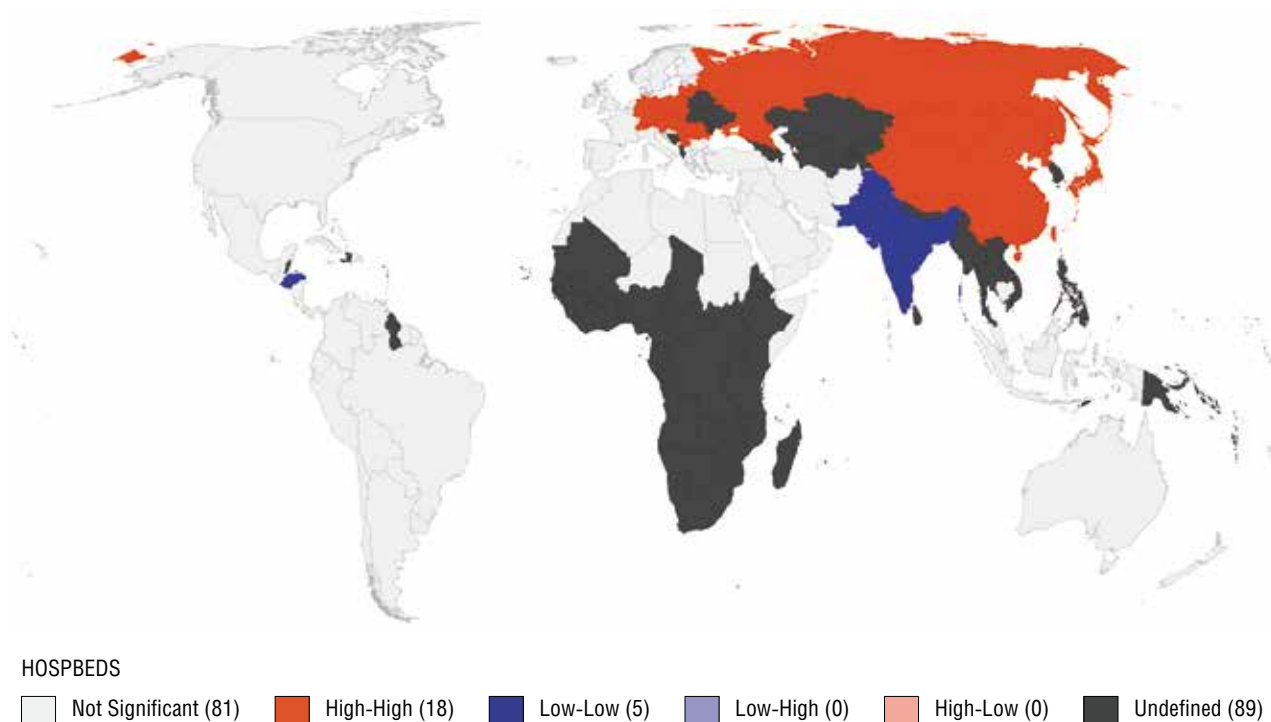


Fig. 6.9.3. “Hospital beds” spatial autocorrelation cartogram for the geometric neighbourhood matrix

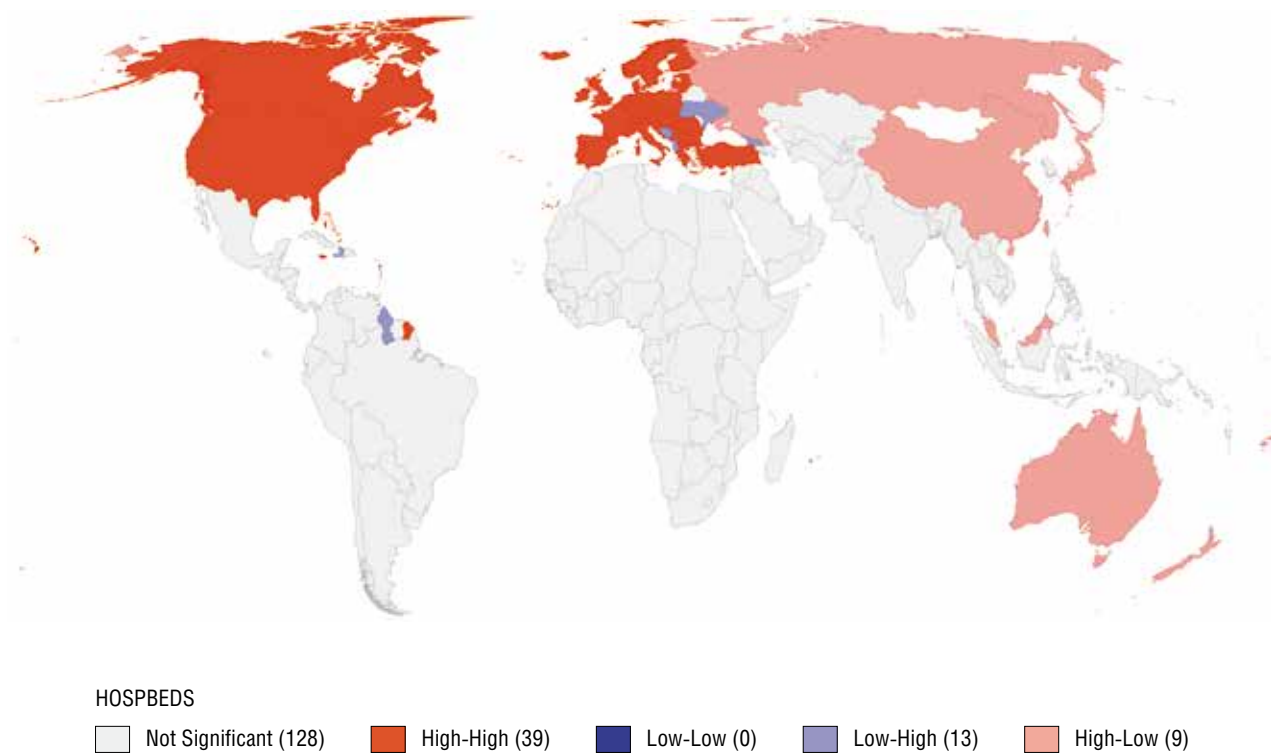


Fig. 6.9.4. “Hospital beds” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.10. Access to electricity

The indicator measuring the percentage of the population with access to electricity is used to assess a country's electrification. This is one of the few indicators in the Atlas where an absolute number of states (103) demonstrate the same indicator value of 100%.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.705	0.000	0.578	0.000
Geary's C	0.302	0.000	0.420	0.000

The percentile cartogram shows a definite North–South divide for this indicator, where countries with maximum electrification are located in Europe and North America, while countries with the lowest indicator values are concentrated in Africa and South and Southeast Asia (Fig. 6.10.1). Nevertheless, we should note that most South American, Middle Eastern and Central and East Asian states have full access to electricity too. Therefore, the North–South rift is not as significant as it is, for instance, for GDP (PPP) per capita, since electrification of a country is a key step towards changing its economic structure and transforming its economy from agrarian into industrial. The cartogram shows that most developing economies have already taken this step.

Against this backdrop, the spatial correlation index demonstrates a strong positive connection for the geometric neighbourhood matrix and a moderately positive connection for the geopolitical neighbourhood matrix. Therefore, the hypothesis that the world's geopolitical structure is more significant is not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix identifies a single cluster in Africa that spans virtually the entire continent, which is explained by high regional concentration of the least developed economies (Fig. 6.10.3). This cluster includes two “error” states, Algeria and South Africa, demonstrating, within the spatial thinking logic, high values for population's access to electricity compared to their neighbours, where access to electricity is more limited. However, when these cases are approached from the economic and historical perspective, the picture makes sense: South Africa is one of Africa's most economically prosperous states, and Algeria owes its high electrification rate to its large deposits of extractable resources and its colonial past, which gave it a head-start in terms of industrial development. Notably, the African cluster does not include Libya, where, according to the percentile cartogram, access to electricity

Global place	Country	Indicator (%)
1–103	103 states	100
Median (1–103)	103 states	100
Mean (139)	Bangladesh	85.16 (84.88)
191	Burkina Faso	14.4
192	Chad	11.8
193	Burundi	11.0

is not high. Nevertheless, as a neighbour of Algeria and Egypt, both full electrified countries, Libya does not make the cluster under the geographic logic.

When compared with the geometric matrix, the geopolitical neighbourhood matrix cartogram does not significantly differ from the previous cartogram (Fig. 6.10.4): we see the same African cluster of economies with low electrification; it is, however, smaller in size, with Chad and Sudan no longer part of it. However, Madagascar, Cameroon, Ghana, Equatorial Guinea and Lesotho are now included in it. In addition to South Africa, the “error” cluster now includes Gabon, where 93% of the population have access to electricity thanks, among other things, to revenues from extractable resources that allowed the country to increase its GDP per capita to four times the average in sub-Saharan Africa. Nevertheless, we see that geopolitical alignment, expressed as membership in a particular integration alliance, has little influence on clustering by autocorrelation criterion.

Our study is also concerned with clusters that did not happen. For instance, there is no cluster of countries with poor electrification in South Asia, potentially because China and Iran, countries with high electrification figures, are located in the same neighbourhood. We observe a similar situation in South America and the Eurasian space, where electrification coverage of the population is close to 100%.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Access to electricity” parameter demonstrates high density of connections in Europe and in Africa (Fig. 6.10.2). Therefore, the test confirms our findings obtained by an analysis of the percentile cartograms and spatial autocorrelation for both high and low indicator values.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	IMF voting power	0.03	0.016	0.203	1.357
2	Ethnic minorities	0.032	0.017	-0.204	1.278
3	Export	0.044	0.004	0.229	1.179
4	Unused export potential	0.032	0.012	0.193	1.132
5	Import	0.038	0.008	0.208	1.125
6	Light pollution	0.028	0.02	0.172	1.022
7	Linguistic diversity	0.191	0	-0.436	0.992
8	Ethnic fractionalization	0.145	0	-0.363	0.907
9	Regional trade agreements	0.15	0	0.358	0.851
10	Cultural solidarity	0.137	0	0.335	0.815

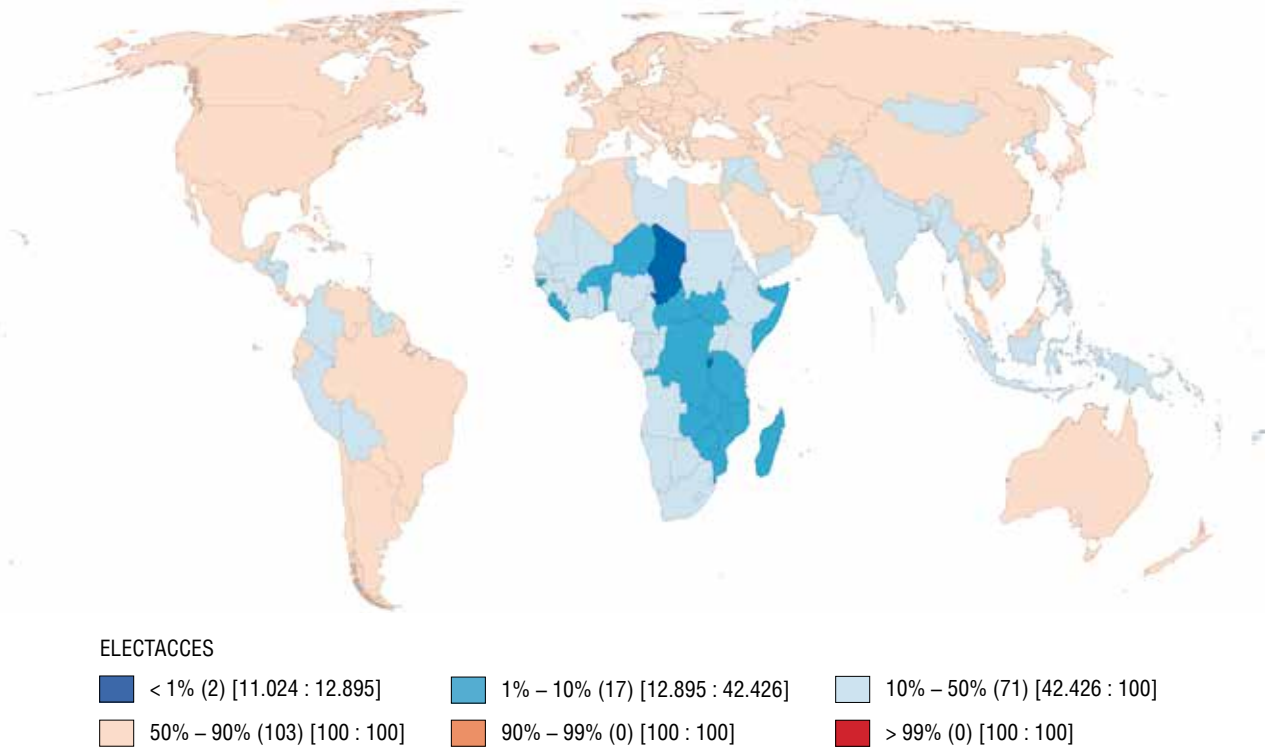


Fig. 6.10.1. Percentile cartogram for the “Access to electricity” indicator

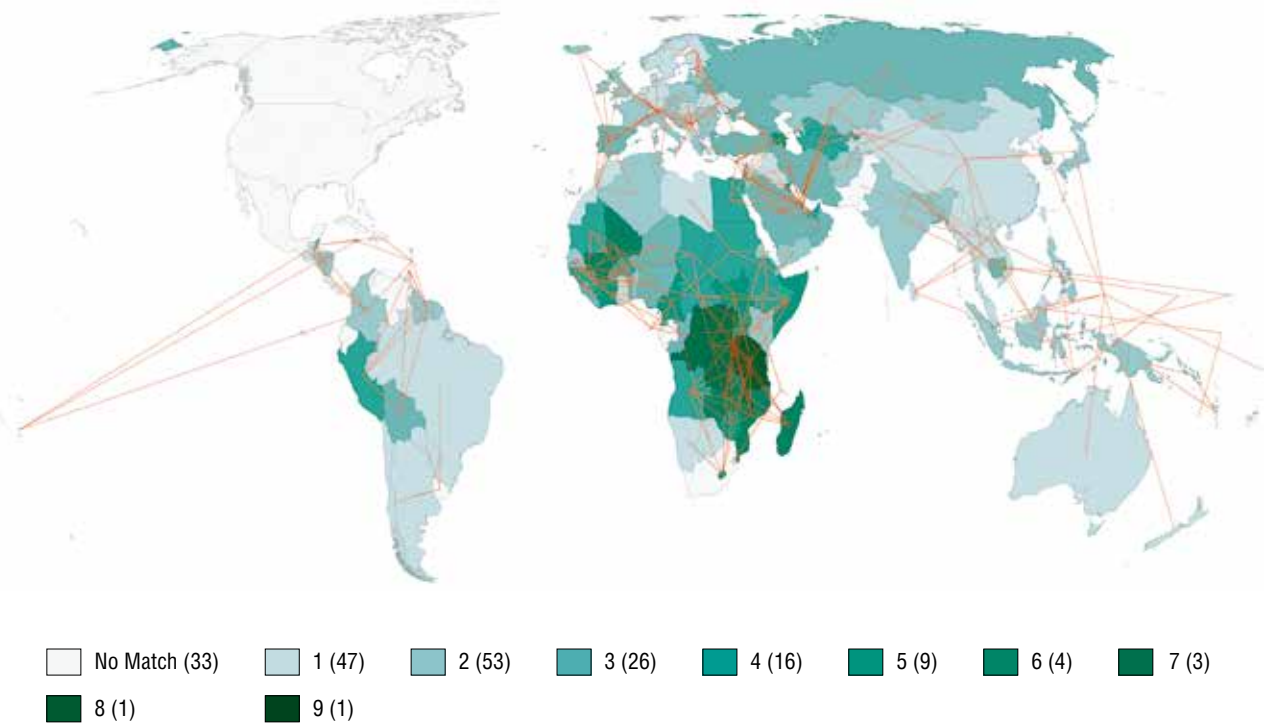


Fig. 6.10.2. Likelihood-ratio test for the “Access to electricity” parameter

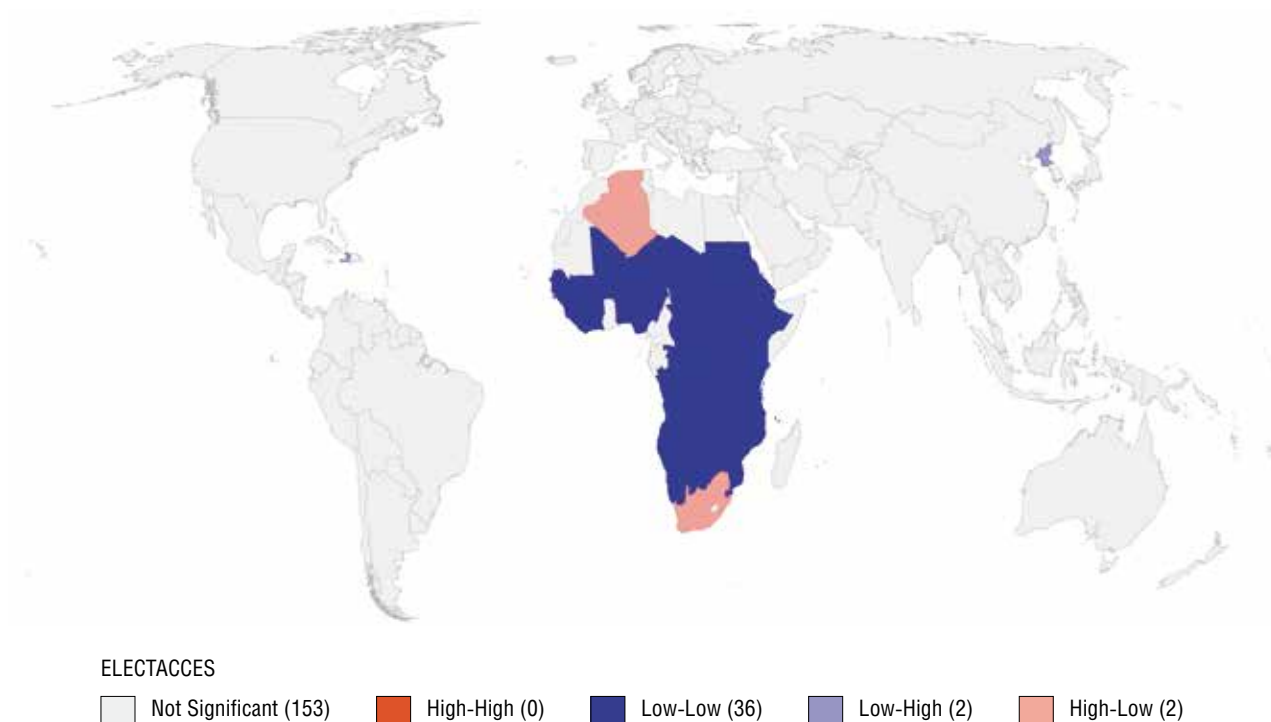


Fig. 6.10.3. “Access to electricity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

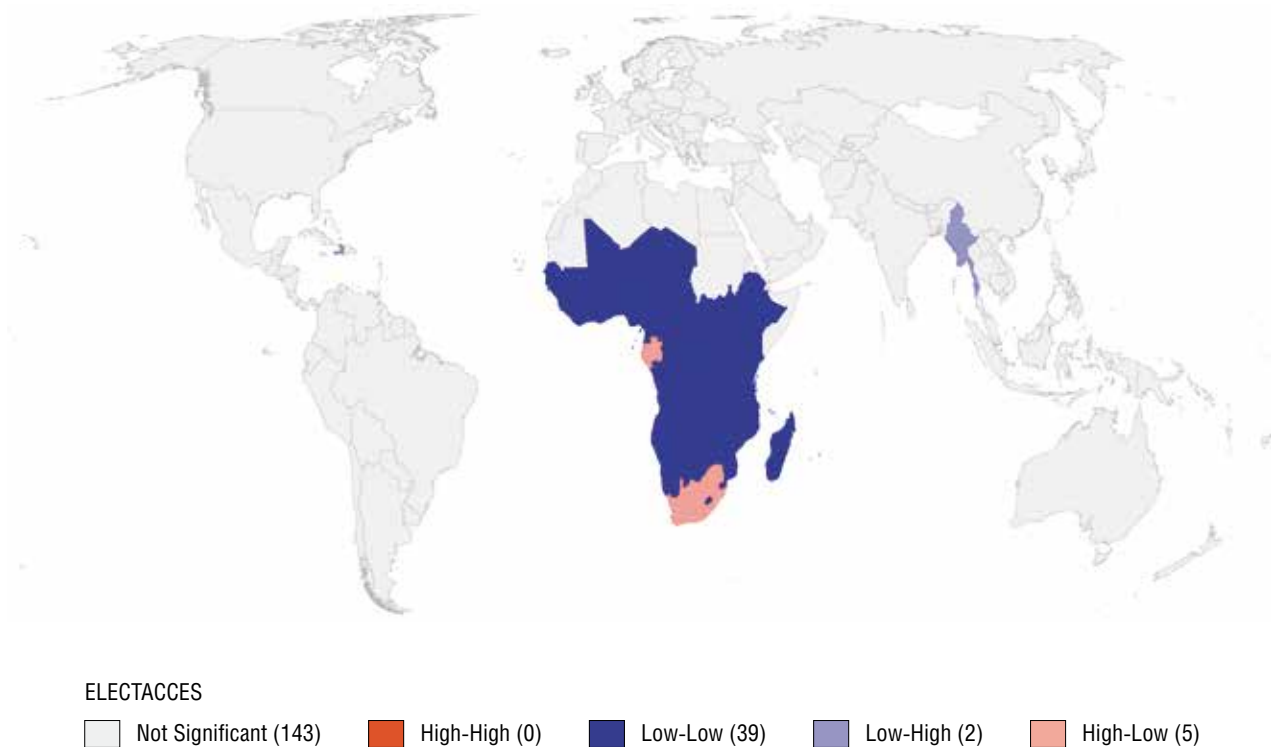


Fig. 6.10.4. “Access to electricity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

6.11. Multifactor analysis of the “Equality” section indicators

Our next step is to conduct a multifactor analysis of the section's indicators using multifactor Geary's C, inverse spatial cluster analysis, and multidimensional scaling.

The indicators under consideration demonstrate significant divergence in their geographic averages since they measure different aspects of global inequality in terms of disposable income, access to the labour market, healthcare, etc.). The greatest gap, however, is recorded for hospital beds per 10,000 population, maternal mortality, and the Gini coefficient.

The geographic average of the number of available hospital beds is skewed northward: even though there is no data for most African countries, other states to the south of the ellipse's centre have indicator values below the global mean: these are countries of Latin America, the Middle East, and South and South-east Asia. The ellipse is stretched from east to west, which is consistent with the high healthcare development levels in developed countries from Japan to the United States.

Analysing the maternal mortality indicator (pregnancy-related deaths per 100,000 live births), the opposite picture is observed. This ellipse is small and located in Africa, where the level of healthcare provision is low. The geographic average is skewed on the equator. Notably, this ellipse is not stretched from west to east, even though maternal mortality in South America and in the southeast of the Asian continent is above the global mean.

The geographic ellipse of economic inequality measured by the Gini coefficient has the largest area. This is consistent with the percentile cartogram for the worldwide Gini coefficient figures (Fig. 6.2.1), where countries of Southern Africa and Latin America have high indicator values. However, countries with insufficiently effective redistribution of income may be found even among developed countries, including the United States and Russia.

Geographic average ellipses by geopolitical bloc demonstrate significant divergences between the spatial distribution of poverty and unemployment. For instance, more countries in the Euro-Atlantic bloc face unemployment problems than poverty problems, which is particularly true for Southern European countries. The geographic centre of the moderately low income ellipse is located in Central and Eastern Europe, which is explained by the socialist past of these countries. A significant gap is recorded in the MERCOSUR-LAIA bloc: the poverty ellipse is stretched northward, where 42% of the Mexican population lives below poverty line (as defined by the national threshold), while the labour force surplus is offset by its export to the US labour market. Another divergence is identified in South Asia: the poverty ellipse in ASEAN+3 is narrow and stretched from Myanmar to Indonesia, while the unemployment ellipse has a greater size and also covers China. When it comes to spatial distribution, the unemployment problems faced by the SAARC bloc are more pressing compared to the poverty problem, and there is a major slant towards Sri Lanka and India. This means that countries within these blocs have similar unemployment indicator values.

The opposite situation can be observed in Southern Africa's SACU-SADC bloc: while the geographic average ellipse for unemployment is located in South Africa, a relatively prosperous country for the continent, the poverty centre is skewed to the northeast to the Democratic Republic of the Congo, Zambia and Mozambique. Notably, no significant divergences are recorded in the CSTO-EAEU-CIS bloc, which evidences relative regional homogeneity.

Multifactor Geary's C helps cluster, using the entire set of indicators in these sections, those states whose neighbours have similar values. However, we should keep in mind that, in the equality group, indicators may provide a multidirectional description of a country's situation: a high Gini coefficient or a high unemployment level are negative equality markers, while many hospital beds or universal access to electricity lead to positive conclusions concerning equality in a country. Six of the section's indicators belong to the first group of negative markers. Consequently, they were used to calculate Geary's C. These are: Poverty level, Economic inequality, Unemployment, Maternal mortality, Female unemployment, and Percentage of Highly wealthy population. Additionally, the significance level is higher here, reaching 0.01.

The geometric neighbourhood matrix yields a fairly heterogeneous and blurred picture with five clusters (Fig. 6.11.1). The first is a Eurasian cluster stretching from Normandy to the Kuril Islands. This cluster includes countries with similar indicator values that are presumably below global mean values. This may be due, on the one hand, to progressive trends in capitalist countries and, on the other hand, to the socialist past in the post-Soviet space. Nevertheless, not all European countries, and not all non-European countries of the former USSR, were able to take advantage of the head start they had in the field of equality. Thus, Southern Europe, some Eastern European countries, Kazakhstan and some other states did not make this cluster.

High scores on the negative equality indicators most likely affected the shaping of other four clusters — that is, countries were clustered by their high inequality. These are the South Asian, West African, Southern African and Latin American clusters. Countries in these groups have high gender and income inequality. With the exception of Togo, relative poverty in Africa is bolstered by ineffective income redistribution mechanisms, while institutional inequality is exacerbated by systemically underdeveloped infrastructure in healthcare, school education and the availability of electricity.

The geopolitical neighbourhood matrix identified a larger number of clusters (Fig. 6.11.2): clusters of such blocs as the Euro-Atlantic bloc (without the United States and Canada), the Latin American bloc (MERCOSUR–LAIA), and the West African bloc (UEMOA–ECOWAS) comprised most of its members. Notably, members of the CSTO–EAEU–CIS bloc did not yield a statistically significant result. This refutes the hypothesis that equality in the countries of the post-Soviet space is influenced by their socialist past.

The cluster analysis cartogram non-adjusted for geographic proximity (Fig. 6.11.3) shows individual groups of neighbouring countries with similar median equality values. The following clusters emerge. A large-scale cluster stretching from Portugal to Japan and including Russia and Mongolia is identified in the Euro-Atlantic space. The European Mediterranean (Italy, Spain, Greece, the Balkans and Turkey, as well as Iran, Georgia and Armenia) forms its own cluster. Surprisingly, the United States, Canada and Kazakhstan are clustered cross-continently. The countries of Central and South America and South and Southeast Asia form their own cross-continental group and demonstrated high levels of inequality in the previous parts of the section. Notably, Uzbekistan is statistically close to the countries of the Persian Gulf, while Ukraine is statistically close to Morocco, Gabon and Uruguay.

The homogeneity observed in Cartogram 6.11.4 is not significantly greater than that in the previous cartogram. Cross-continental clusters collapse, and Canada here tends toward the Euro-Atlantic cluster, while the United States belongs with Central American countries. Latin America south of Peru and Brazil forms a single group, which is consistent with geographic proximity principles. At the same time, unlike the geographic proximity cartogram, the region forms its own cluster comprising Cuba, the Bahamas, Belize, Guyana and Suriname.

Asia appears more homogeneous, but clusters within it are more fragmented: while the space in Asia's southeast is monolithic from China to Thailand and Sri Lanka, Tajikistan in central and eastern parts exhibits greater similarity to North Africa and Iran than to its neighbours Pakistan and Uzbekistan, and Kyrgyzstan actually fits into the Mediterranean cluster of statistical proximities. This may indirectly testify to the favourable consequences of those democratic reforms that the Central Asian state has been, implementing since gaining independence, with varying degrees of success. Australia, New Zealand, and the Southeast Asian states south of Thailand form another monolithic group located in Asia.

Unlike the first statistical proximity cartogram, Africa exhibits greater homogeneity, but still constitutes a patchwork of five clusters, the largest being the West African cluster stretching from Mauritania to Chad, but not including Senegal and Togo, which turn out to be statistically proximate to the Democratic Republic of the Congo, the Central African Republic and Kenya.

The scatter plot (Fig. 6.11.5) showing the results of multidimensional scaling of countries by equality indicator values demonstrates significant spread by quadrant (Fig. 6.11.6). However, a denser nucleus may be identified closer to the beginning of the Y-axis at the juncture of quadrants 1 and 4. This nucleus includes



Fig. 6.11.1. “Equality” section spatial autocorrelation cartogram for the geometric neighbourhood matrix

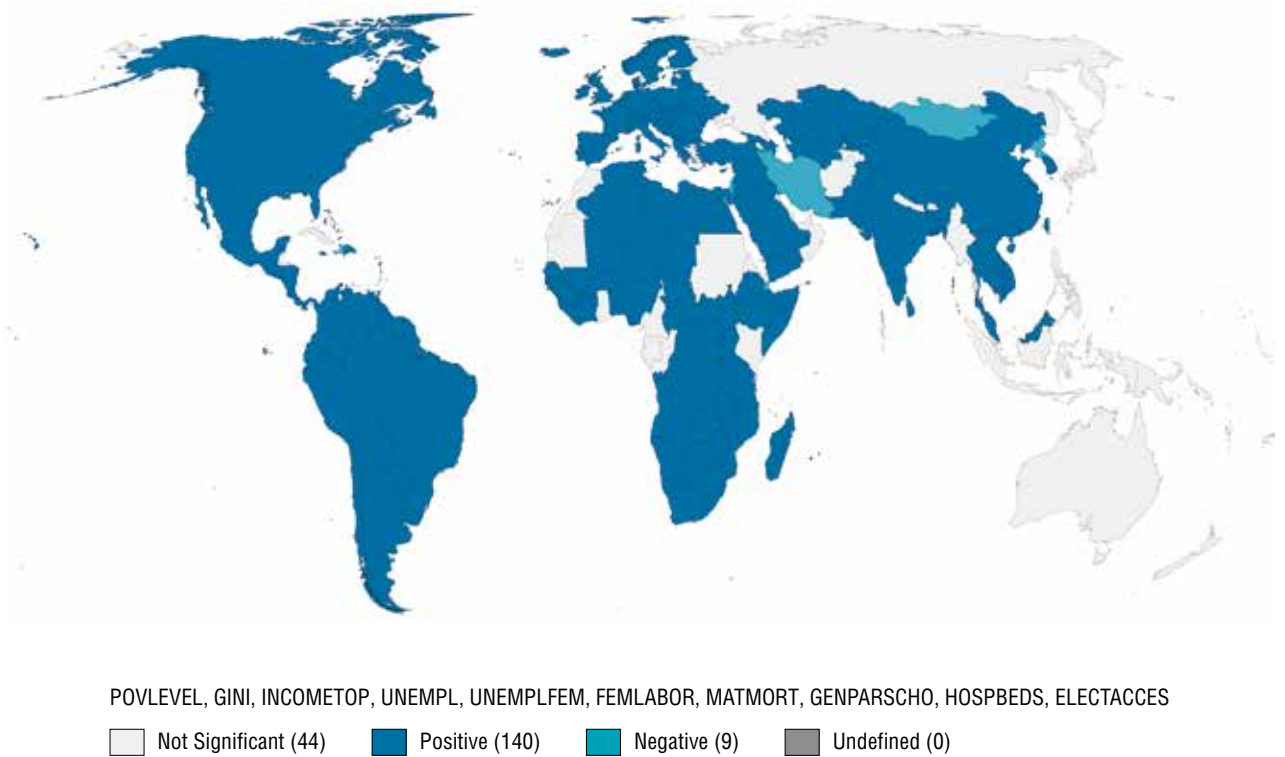


Fig. 6.11.2. “Equality” section spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

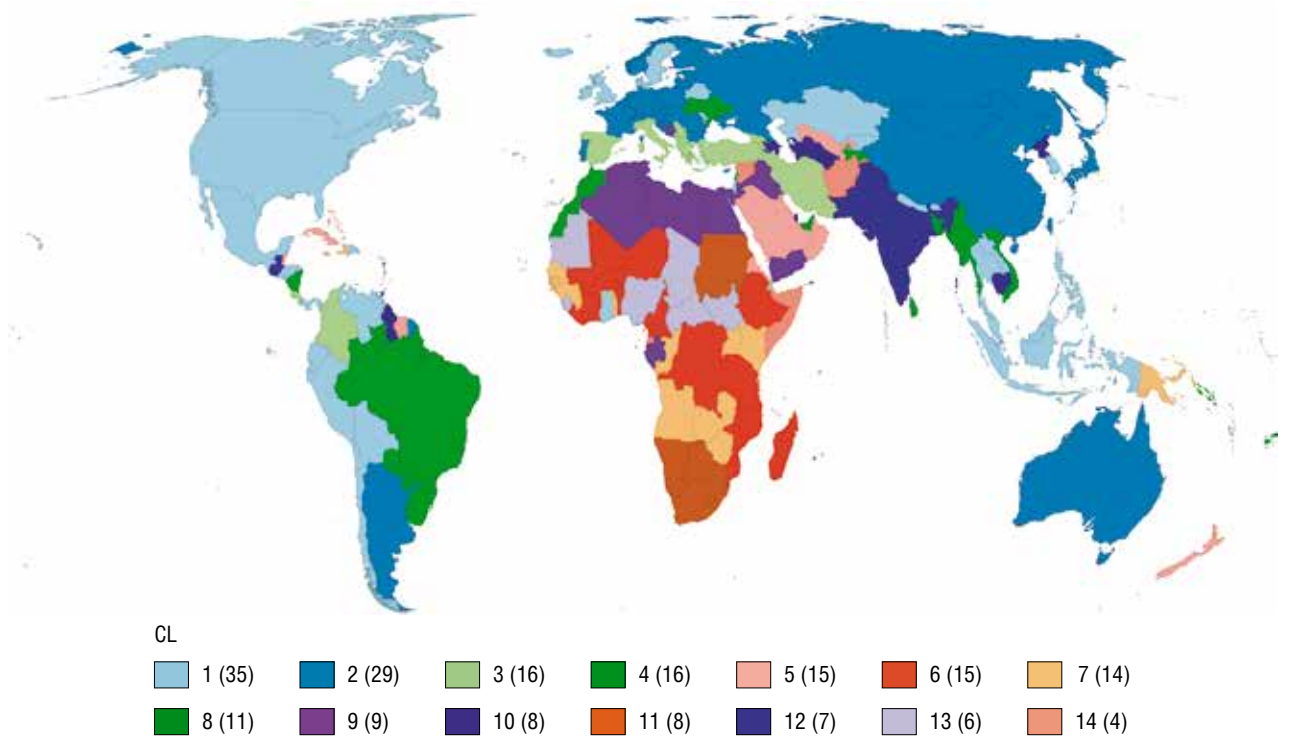


Fig. 6.11.3. Statistical clusters cartogram for the "Equality" section indicators

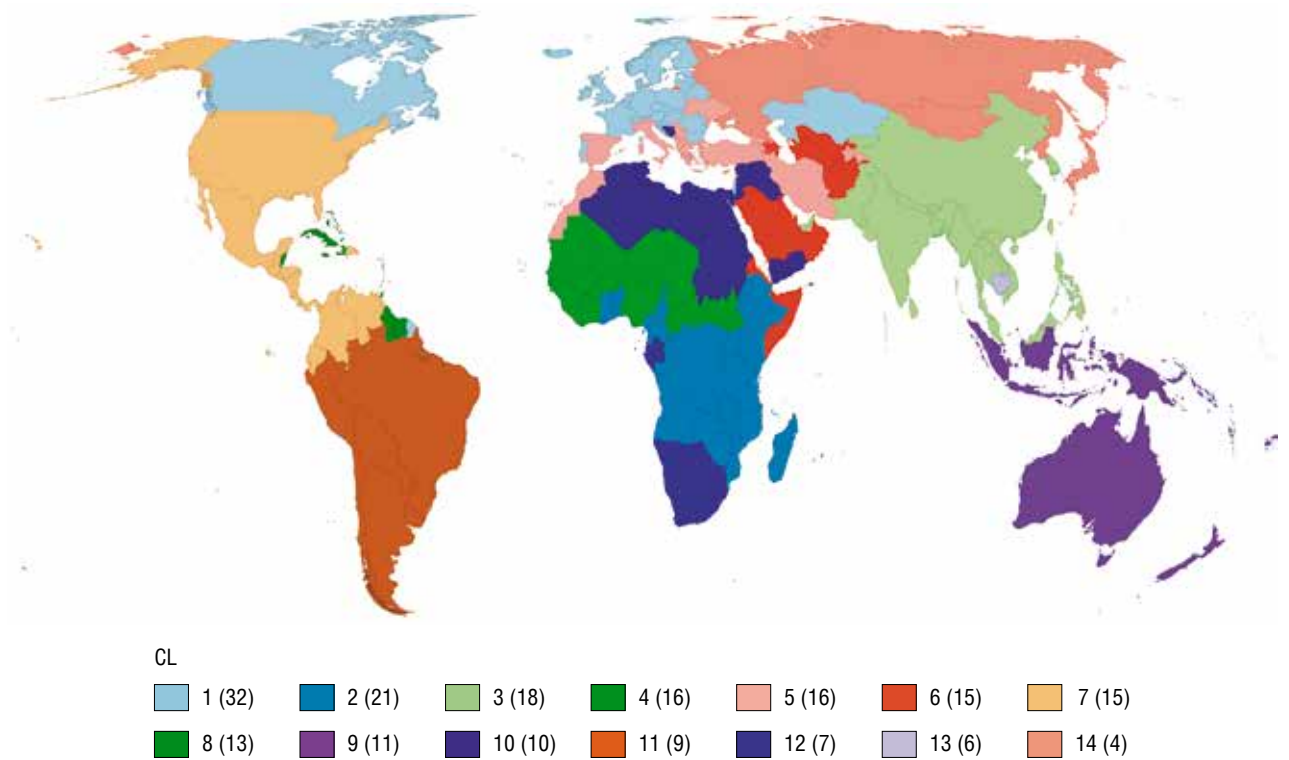
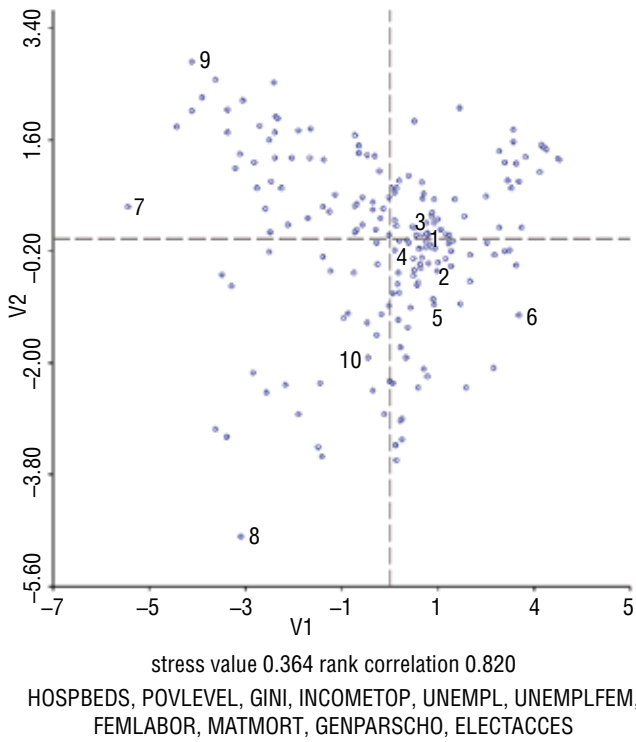


Fig. 6.11.4. Statistical clusters cartogram for the "Equality" section indicators adjusted for geographic proximity



1	China
2	US
3	Russia
4	Sweden
5	France
6	Saudi Arabia
7	South Sudan
8	South Africa
9	Chad
10	Brazil

Fig. 6.11.5. Multidimensional scaling chart for the “Equality” section indicators

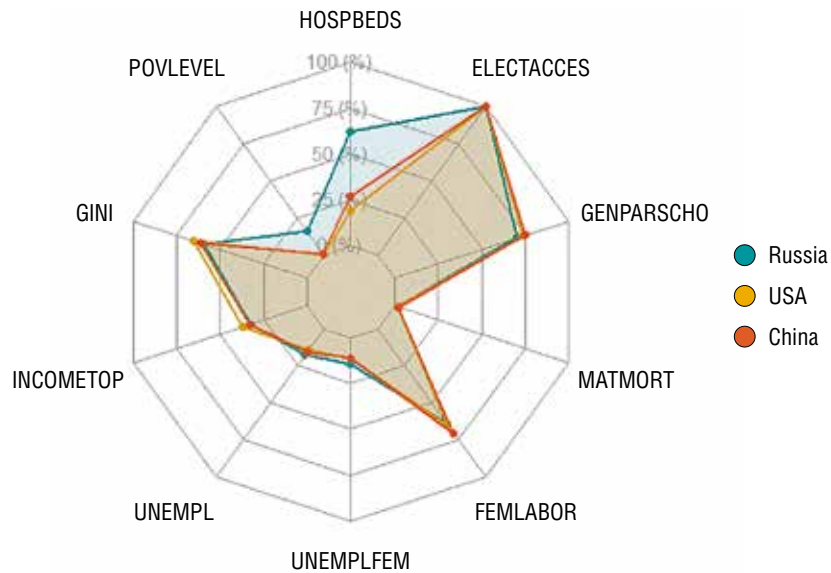


Fig. 6.11.6. Radar chart for the “Equality” section indicators

Northern hemisphere countries from the United States to South Korea, as well as India and Australia. Nevertheless, it does not include states along the Spain–Turkey–Vietnam line. Considering the left and right halves individually has greater analytical value for this study. The left half mostly includes countries of Latin America (excluding Chile), Africa (excluding the north of the continent) and half of Southeast Asia. The right half includes the United States, Canada, nearly all of the Eurasian continent (with the exception of Myanmar, Pakistan, and Tajikistan) and the Middle East. We could propose the hypothesis that developed countries have higher equality levels and are clustered in the right part of the chart, yet, sadly, since quadrant 4 includes both Middle Eastern and Western European countries, this hypothesis cannot be confirmed. Therefore, multidimensional scaling does not explain the geographic distribution of equality indicators along the North–South line.

6.12. Spatial factor and “Equality” section indicators

A regression analysis of the “Equality” section indicators revealed the linear regression model presented below, where “Access to electricity” is the dependable variable. Its distribution is negatively affected by “Poverty level” and “Female labour” and is positively influenced by “Secondary education enrolment” and “Expected years at school.” This model may be interpreted in the following manner:

- Poverty among the population indicates, among other things, a shortage of resources required for electrification. Additionally, the purchasing power of the poor population is too low to allow people to regularly use electricity.
- A more educated population is, as a rule, employed in a greater variety of economic sectors, including more energy-intensive sectors.
- It is not entirely evident why female employment has the inverse effect on electrification, but the following hypothesis may be advanced: high female employment is typical for developing states, particularly sub-Saharan Africa. Consequently, women in poor communities without access to electricity are forced to do work on par with men, and the regression model reflects this fact. Nevertheless, this proves a statistical, rather than a causal nature of this connection.

Notably, access to electricity is one of the few indicators where 57% of the sampling demonstrate the same value of 100% (103 out of 181 countries).

When the model’s validity is assessed for the world’s political map, the relevant cartogram shows that this regression has the greatest explanatory potential for states of South and Southeast Asia, and Central and South America (with the exception of Brazil, Chile, Suriname, Guyana and French Guiana). The highest R-squared values are shown by Cambodia, Laos, Vietnam, Nepal, Afghanistan, Gabon, Guatemala and Honduras. On the one hand, these are countries where high levels of inequality are recorded throughout the section. On the other hand, the hypothesis of the model’s validity for developing countries is not confirmed by the low R-squared for almost the entire African continent.

A comparison between regression models for the spatial lag model (SAR) and the spatial error model (SEM) shows that the latter is preferable from the point of view of the significance of the Lagrange multiplier. Lower values for the Akaike information criterion indicate that SEM spatial models are more valid than the non-spatial OLS model. Lower values of the Akaike information criterion and the Schwarz information criterion support the geometric neighbourhood matrix, although the values differ very slightly. The situation with R-squared is similar: a model adjusted for geometric spatial neighbourhood weights distribution shows higher values compared to the “geopolitical” ones.

At its inception, this section was conceived as heterogeneous and capable of providing a multi-aspectual statistical picture of inequality and social justice. For this, social, economic and gender quantifiable equality parameters were selected. The application of spatial econometrics methods to these parameters yields a rather motley picture where certain regularities can nevertheless be identified.

Model selection criterion	Indicator	Value	Significance level
Normality of errors	JB p-value > 0,1	—	0,560421
Heteroskedasticity	K (BP) p-value < 0,05	—	0,00
Multicollinearity	VIF < 7,5	1,60	—
Spatial Autocorrelation	Moran's I p-value > 0,1	—	0,55
Lagrange Multiplier — Geometry Weights	Lagrange Multiplier (lag)	10,8104	0,00
	Robust LM (lag)	1,6057	0,21
	Lagrange Multiplier (error)	13,9119	0,00
	Robust LM (error)	4,7072	0,03
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (lag)	10,8104	0,00
	Robust LM (lag)	1,6057	0,21
	Lagrange Multiplier (error)	13,9119	0,00
	Robust LM (error)	4,7072	0,03

	OLS	SEM geometry	SEM geopolitics
Constant	77,138422 (0,00000)	67,2148 (0,00000)	67,857 (0,00000)
POVLEVEL	-0,398279 (0,00000)	-0,290917 (0,00300)	-0,273428 (0,00071)
FEMLABOR	-0,361235 (0,00000)	-0,394198 (0,00000)	-0,450151 (0,00000)
ENRSEC	0,153304 (0,00007)	0,346889 (0,00000)	0,334446 (0,00000)
SCHYEARS	2,707576 (0,00000)	1,94927 (0,00086)	2,27019 (0,00014)
LAMBDA	—	0,474128 (0,00000)	0,542417 (0,00000)
Heteroskedasticity (Breusch-Pagan test)	48,916267 (0,00000)	41,7555 (0,00000)	40,9986 (0,00000)
Normality of errors (Jarque-Bera test)	1,158134 (0,560421)	—	—
Spatial dependence (Likelihood Ratio test)	—	22,1457 (0,00000)	22,0054 (0,00000)
Akaike info criterion	1577,12	1027,81	1027,95
Schwarz criterion	—	1042,26	1042,4
R-squared	0,683361	0,834389	0,830650

* P (P-value) significance level is given in brackets.

As regards spatial distribution of equality, Access to electricity and Maternal mortality demonstrate the greatest autocorrelation (by Moran's I and Geary's C), while Gender parity at primary and secondary school, Unemployment, and Income of the top 20% of the population demonstrate the least autocorrelation. Going back to the study's overarching hypothesis regarding the primacy of geopolitical global structure over absolute geographic distribution of countries, we should note that this hypothesis is not confirmed for equality indicators. For only two indicators, the Gini coefficient and Income of the top 20% of the population, Moran's I and Geary's C demonstrate a greater connection under the geopolitical neighbourhood matrix compared to the geometric matrix. Both are economic indicators and are connected since the Gini coefficient measures economic inequality in income distribution, while their values for spatial autocorrelation metrics evidence a weak positive connection.

As for the other eight equality indicators, values with high spatial autocorrelation for geometric neighbourhood also demonstrate high autocorrelation for the geopolitical matrix. Spatial autocorrelation cartograms shows that strong neighbourhood effect is usually present in Africa, continental Europe, Southeast Asia and Latin America.

In assessing the spatial effect for equality metrics, we transitioned to the next level, namely, an analysis of the world's connectedness by two indicators. Here, we identified those indicators from other sections whose spatial distribution correlates strongly with equality indicators. Comparing how frequently indicators are featured in spatial effect tables for equality, a leader emerges — Population growth rates, which demonstrates a spatial correlation with six indicators in the group. Linguistic diversity is second (five indicators out of ten), followed by Access to electricity and Income of the top 20% of the population, Female labour, Regional trade agreements, and Unused export potential in third. Special attention should be paid to two things: first, out of the six indicators identified, three belong to the equality group themselves. This means that socioeconomic rights and freedoms are strongly mutually connected not only in their essence, but also in their geographic distribution. Second, a strong connection between equality indicators and demographic factors such Population growth potentially suggests that the situation with equality and social justice differs depending on whether the country in question has the first or second type of population reproduction. This allows the research team to advance the hypothesis that the notional division into developed and developing countries is relevant for the spatial distribution of the equality phenomenon, too.

We tested this hypothesis through multifactor analysis, taking equality indicators in their totality rather than individually. Multidimensional scaling did not confirm the North–South rift hypothesis. This is certainly a preliminary conclusion, obtained by using methodologically restricted set of tools, so additional research needs to be conducted.

A similar situation is observed for the geometric/geopolitical neighbourhood matrices: multifactor Geary's C and an inverse spatial cluster analysis clearly demonstrated that geographic factors prevail over the current balance of power and configuration of connections in international relations. We recorded individual connections between culturally and historically close states in the Middle East, Western Europe, and South and Southeast Asia, but the overall picture for the distribution of equality is still heterogeneous. Therefore, economic, social and gender equality as a phenomenon is a less “geographically concentrated” category, which has a positive effect. This means that human rights and social justice are not something specific for the countries of the notional West, and developing countries are not doomed to institutionally reproduce inequality in accordance with the “path dependence” theory.

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7

Education and Science

Primary education enrolment

Secondary education enrolment

Tertiary education enrolment

Quality of school education

Years at school

Primary school dropouts

Education spending

Number of researchers

R&D spending

Publication activity

TEN indicators were selected for the “Education and Science” section. Each indicator meets at least five out of the seven criteria outlined in the “Research methodology” section. To normalize indicators, we used population numbers (enrolment figures for the three tiers of education and number of researchers) and its gross domestic product (GDP) (for education and research spending).

Since the Atlas is intended to provide a stereoscopic picture of human capital development across the world, indicators for the “Education and Science” section were selected in such a way as to provide a comprehensive idea of the educational and academic potential of countries. This potential is reflected in three dimensions: coverage (large-scale involvement), quality (productivity) and funding. Coverage includes indicators for the three tiers of education and numbers of researchers. Quality is measured by years in school (regular and adjusted for education results), the percentage of dropouts, and number of articles. Funding is represented by governmental spending on education and science.

Enrolment in primary, secondary and tertiary education is the key indicator of accessibility and prevalence of educational services in a country. In the long term, an increase in the proportion of the population enrolled in schools and universities leads to improved socioeconomic conditions, reduces inequality, and has a positive effect on people’s health and the country’s environmental situation [McMahon & Appiah 2002].

Primary education enrolment measures the percentage of children who attend primary school. Primary education is the basic stage in school education, it shapes the skills required to take on educational programmes in the future. Primary education lays the foundations for personal development, promotes tolerance and improves further employment opportunities [Benavot 2014; Walker et al. 2019].

To indirectly assess the level of acquisition of basic knowledge and skills, we use the “Percentage of primary school dropouts” indicator. Failure to complete primary education results in insufficient mastery of the fundamental skills (reading, writing, maths), which further reduces their chances of finding a job in the future. Additionally, primary school dropouts translate into the country’s economic losses since the resources the state earmarks for funding primary education are wasted. For instance, in 2007, Malawi lost USD 60 million (1.3% of its GDP) for this very reason [Sabates et al. 2010].

Secondary education is the second and concluding part of school education. The school education enrolment indicator shows the percentage of the population that has completed the compulsory school programme. School education forms the basis for further continuous education and offers greater possibilities for

future employment and personal development, which has a positive impact on the population's human development [Craigwell, Bynoe & Lowe 2012; OECD 2012].

Tertiary education includes public and private universities, colleges, vocational colleges, and other post-school educational institutions. Tertiary education plays an important role in stimulating economic growth, reducing poverty and improving the overall wellbeing of the population. Highly qualified professionals are more likely to demonstrate high levels of civic involvement, and find good well-paying jobs. The results of their professional activities have a positive impact on the country's R&D output, which increases the number of innovations that might accelerate its economic and social development [Egerton 2002; Mourshed et al. 2013; Volchik et al. 2018; OECD 2012; UNESCO 2020]. The tertiary education enrolment indicator shows the percentage of the population that is enrolled in higher education institutions.

One of the basic indicators of the level of education and human capital is data on average years at school. The higher the figure, the better educated the graduates are. Consequently, high indicator values indicate greater chances of moving on to tertiary education and acquiring skills that are in high demand on the job market. The expected years in school indicator adjusted for education results makes it possible to assess not only the number of years spent at school, but also the quality of education, since test results are figured into its calculations [Filmer et al. 2020].

Government education spending is a crucial social development indicator, as it shows whether education is of high or low priority in a country. Funding from international organizations and non-governmental organizations (NGOs) is also taken into account when calculating scores for this indicator.

The state remains the crucial source of funding for fundamental research, applied research, and experimental research and design, since as governmental investments increase, the business sector also grows more inclined to invest in R&D [Soete et al. 2015]. Promoting and advancing research ensures progress. Therefore, data on public spending on R&D is a key indicator of scientific development being prioritized in a given country's policies. High R&D spending stimulates scientific productivity, which, in turn, improves a given country's technological potential.

There is a synergistic effect between investment in higher education and R&D and the number of researchers working in R&D. The latter figure shows the level of development of research and technological activities in countries, and also indirectly attests to the popularity of R&D employment.

Another indicator that indirectly shows how popular a career in sciences is the number of articles in scientific and technological journals. The greater the number of articles, the more effective a country's academic system is from the point of view of investment and the number of employed researchers [Kumar, Stauvermann & Patel 2016].

7.1. Primary education enrolment

Primary education enrolment reflects the accessibility and coverage of basic educational services in a country. This is measured as the ratio of the number of primary school students regardless of age to the number of the population age group that officially corresponds to this level of education. The closer the indicator value is to 100%, the more balanced a given country's education system is. A high enrolment ratio reflects a large number of older students who remain in primary school due to delayed enrolment or because they have to repeat grades.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.100	0.012	0.071	0.005
Geary's C	0.833	0.006	0.924	0.005

Imbalances in educational systems are, as a rule, typical for countries with low socioeconomic development levels. The percentile cartogram shows that Africa is the continent with the highest polarization of primary education enrolment (Fig. 7.1.1). The problem with the extent of literacy and basic skills is most urgent for African population. Sweden also shows high primary education enrolment. This may be because the country receives a large number of refugees every year that are integrated into society via, among other things, educational institutions.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix reveals three clusters where enrolment in primary education is low (Fig. 7.1.3). The first cluster mostly includes the countries of sub-Saharan Africa. Against the backdrop of generally low socioeconomic development, these countries demonstrate extremely low enrolment numbers in primary education: even the relevant age group is not covered by educational services. The second cluster is an "exception cluster" located in the south of Africa. South Africa and Zambia, more economically developed countries, have better-balanced educational systems compared to their neighbouring countries: primary education enrolment here approaches 100%. Therefore, the neighbourhood principle does not work in this instance: indicator values for these countries are relatively low, while their neighbours scored highly. Then there is the Eastern European cluster, in which Moldova and Bulgaria demonstrate lower enrolment numbers in primary education.

Global place	Country	Indicator (%)
1	Malawi	145.5
2	Nepal	143.9
3	Madagascar	143.8
Mean (85–86)	(Botswana, Kenya)	103.2169 (103.2)
Median (92)	France	102.4
181	Djibouti	69.6
182	Eritrea	68.5
183	Equatorial Guinea	61.8

The geopolitical neighbourhood matrix cartogram shows several spatial clusters mostly located in Africa (Fig. 7.1.4). One is in Southern Africa. Generally, this region demonstrates high enrolment numbers in primary education: educational systems try to make up for the past lag, and many older children are enrolled in primary schools. Relatively highly economically developed countries such as South Africa, Zambia and Botswana score lower compared to their neighbours.

A cluster of countries with lower enrolment numbers in primary education emerged in the west of Africa: due to the low socioeconomic development level of the countries in this cluster, even the relevant age group is not, as a rule, covered by educational services. The exceptions here are Ghana, Togo, Benin, Sierra Leone and Guinea Bissau. The neighbourhood principle does not work here: enrolment in primary education here are higher than in the region overall.

Another cluster emerges in the north of Africa, which is part of the Arab world (Morocco, Algeria, Egypt, Tunisia). Both economic factors and sociocultural features (for instance, the coordinated efforts of Arab countries on matters of education¹) result in increased primary education enrolment in these countries.

In the geopolitical neighbourhood matrix, the Persian Gulf differs from the point of view of primary education enrolments. The high scores for the United Arab Emirates and Oman which identifies these countries as drivers of the region's transformation, including from the point of view of the status of women and women's education.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Primary education enrolment" parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram (Fig. 7.1.2) clearly shows integration in Europe, since a group of states with similar primary education enrolment figures are clustered here. Additionally, visible clusters of countries with similar primary education enrolment figures emerge in Latin America and West Africa. Particularly striking here are Russia's isolation (the absence of a post-Soviet node of connections in such a relatively conservative realm as education illustrates the transformation of the region and the destruction of apparently solid ties) and the fact that there is no observable node of connections in the Middle East (high regional diversification).

Below, we list nine pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Highly wealthy population	0.037	0.019	0.143	0.553
2	Economic inequality	0.030	0.034	0.114	0.433
3	Female labour	0.035	0.015	0.118	0.398
4	Voter turnout	0.026	0.036	0.098	0.369
5	Refugees	0.034	0.022	-0.093	0.254
6	Gender parity at school	0.091	0.001	0.114	0.143
7	Renewable energy	0.078	0.000	0.090	0.104
8	ARV therapy	0.040	0.033	0.058	0.084
9	Education spending	0.053	0.017	0.057	0.061

¹ For instance, in 1978, the Convention on the Recognition of Studies, Diplomas and Degrees in Higher Education in the Arab States was adopted.

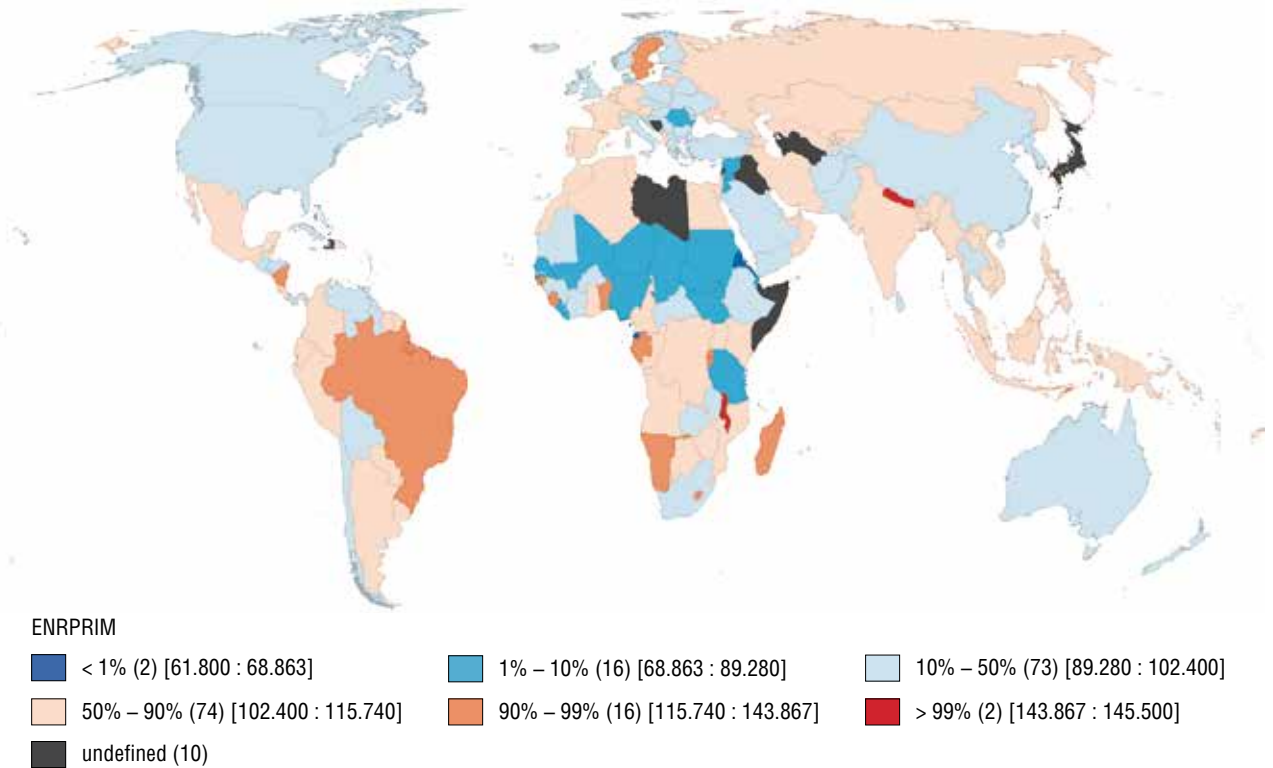


Fig. 7.1.1. Percentile cartogram for the “Primary education enrolment” indicator

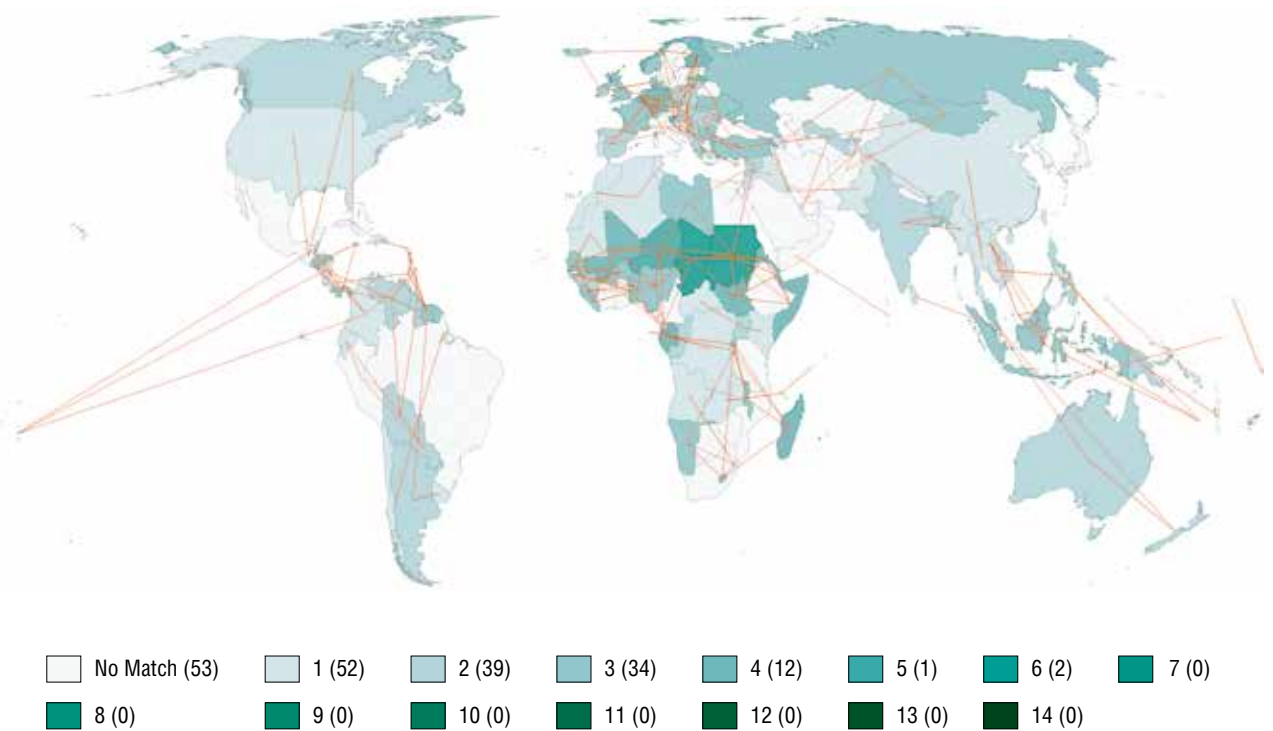


Fig. 7.1.2. Likelihood-ratio test for the “Primary education enrolment” parameter

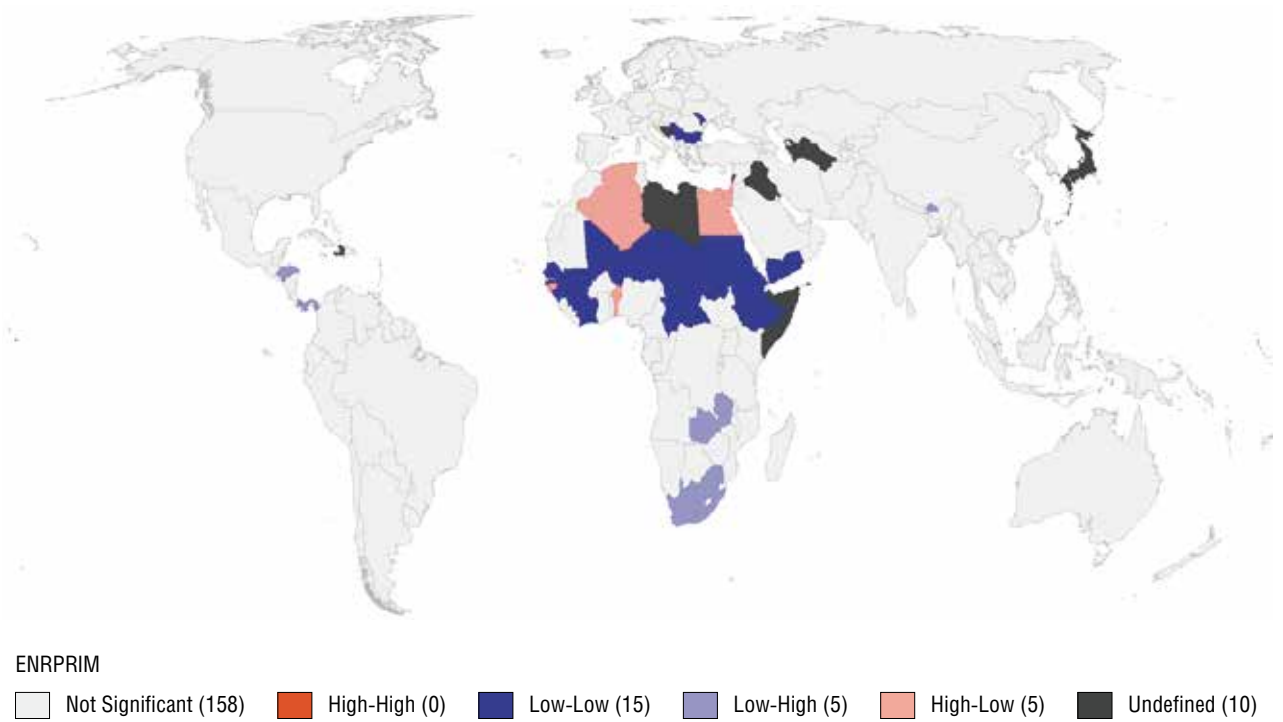


Fig. 7.1.3. “Primary education enrolment” spatial autocorrelation cartogram for the geometric neighbourhood matrix

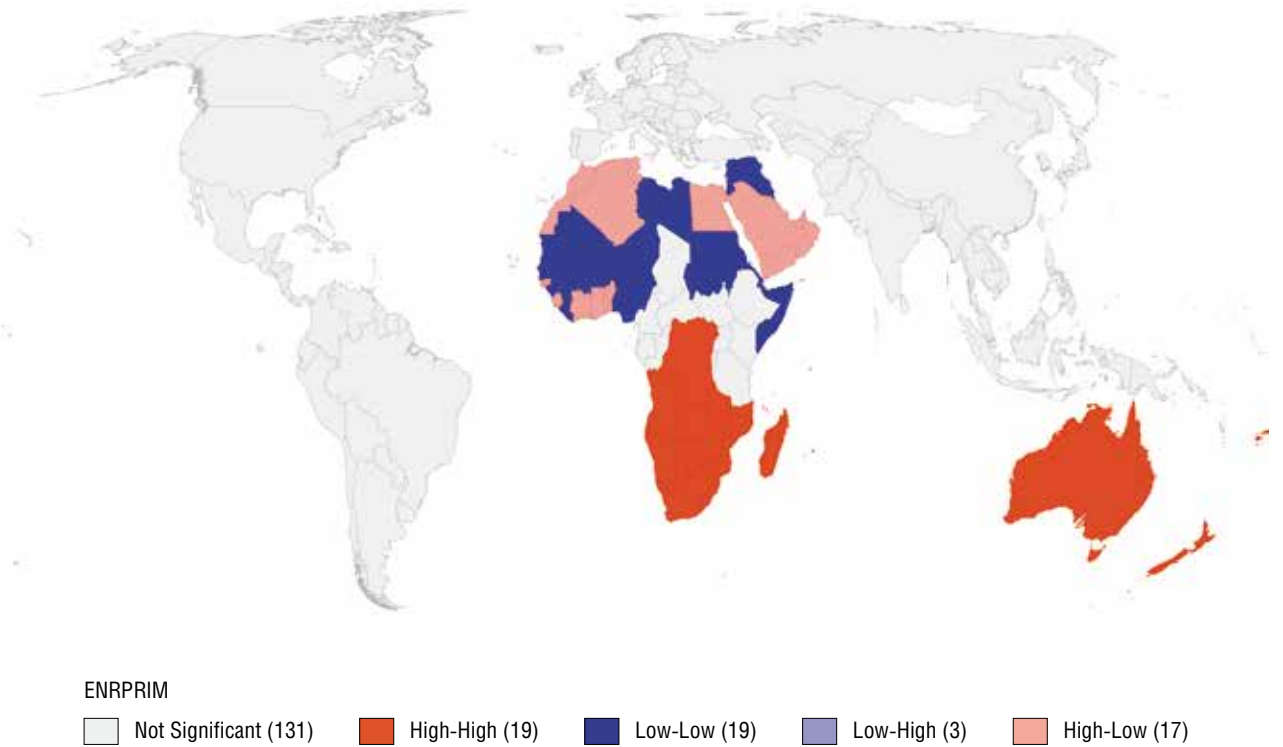


Fig. 7.1.4. “Primary education enrolment” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.2. Secondary education enrolment

Gross enrolment ratio in secondary education measures the percentage of the population enrolled in secondary education programmes. The value of this indicator' may be over 100% in those cases when people enrolled in secondary school are outside the relevant age group.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.423	0.000	0.305	0.000
Geary's C	0.548	0.000	0.692	0.000

The percentile cartogram (Fig. 7.2.1) shows that the highest indicator values are mostly observed in European countries, which is likely because migrants and refugees are socially integrated into host states by giving them access to secondary education, among other things. The lowest indicator values are observed in poor African countries, where governments cannot meet the growing needs of their people for secondary education due to funding and personnel shortages and because the authorities are not sufficiently invested in resolving this problem.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 7.2.3) shows two stable clusters: an African cluster of low indicator values and a Northern European cluster with high enrolment figures in secondary education. Countries of the first cluster are characterized by low levels of socioeconomic development, which explains why even the relevant age group is poorly covered by secondary education. Countries of the second cluster, which includes the Scandinavian states, the United Kingdom, Belgium, Russia and Belarus, have high indicator values.

The geopolitical neighbourhood matrix cartogram shows two spatial clusters (Fig. 7.2.4). The first, Euro-Atlantic, cluster demonstrates high levels of secondary education enrolment. Unlike the geometric neighbourhood matrix, the geopolitical neighbourhood matrix includes virtually all the countries of

Global place	Country	Indicator (%)
1	Belgium	158.5
2	Finland	154
3	Sweden	152.9
Median (85)	Mongolia	91.5
Mean (103)	(Malaysia)	85.4746 (85.4)
167	Chad	20.7
168	Central African Republic	17.1
169	South Sudan	11

Europe, Canada and the United States in this cluster. North Macedonia is an exception here. Under the geopolitical neighbourhood matrix, Russia and Belarus no longer belong to the cluster of states with high enrolment figures in secondary education since they are part of a different geopolitical bloc.

The second (African) cluster includes most sub-Saharan countries, where enrolment figures in secondary education are low. This cluster spans the countries of the UEMOA–ECOWAS and SACU–SADC, which is explained not by integration trends, but rather by their low socioeconomic potential. South Africa stands out here since, compared to its neighbours, it has higher indicator values, which is due to its relatively high economic development.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Secondary education enrolment” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration (Fig. 7.2.2). The cartogram clearly shows three equally intensive nodes with the most similar secondary education enrolment figures: the European node, West African node, and South African node. Notably, there is no stable connection between countries of North America and Europe, which belong to the same bloc and form a cluster under the geopolitical neighbourhood matrix.

The cartogram shows prerequisites for the formation of a stable cluster of Latin American and Caribbean states due to their similar socioeconomic development levels, geographic proximity, and common strategic interests.

Notably, there is no stable connection between countries of North America and Europe. There is also no post-Soviet node, which suggests that there is a pronounced difference between Russia and Central Asian countries in secondary education enrolment.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	IMF voting power	0.041	0.009	0.229	1.279
2	Unused export potential	0.034	0.018	0.180	0.953
3	Export	0.065	0.001	0.247	0.939
4	Import	0.053	0.003	0.217	0.888
5	Ethnic fractionalization	0.152	0.000	-0.350	0.806
6	Cultural solidarity	0.162	0.000	0.354	0.774
7	Population growth	0.248	0.000	-0.430	0.746
8	Linguistic diversity	0.229	0.000	-0.413	0.745
9	Depletion of natural resources	0.082	0.000	-0.245	0.732
10	Regional trade agreements	0.316	0.000	0.465	0.684

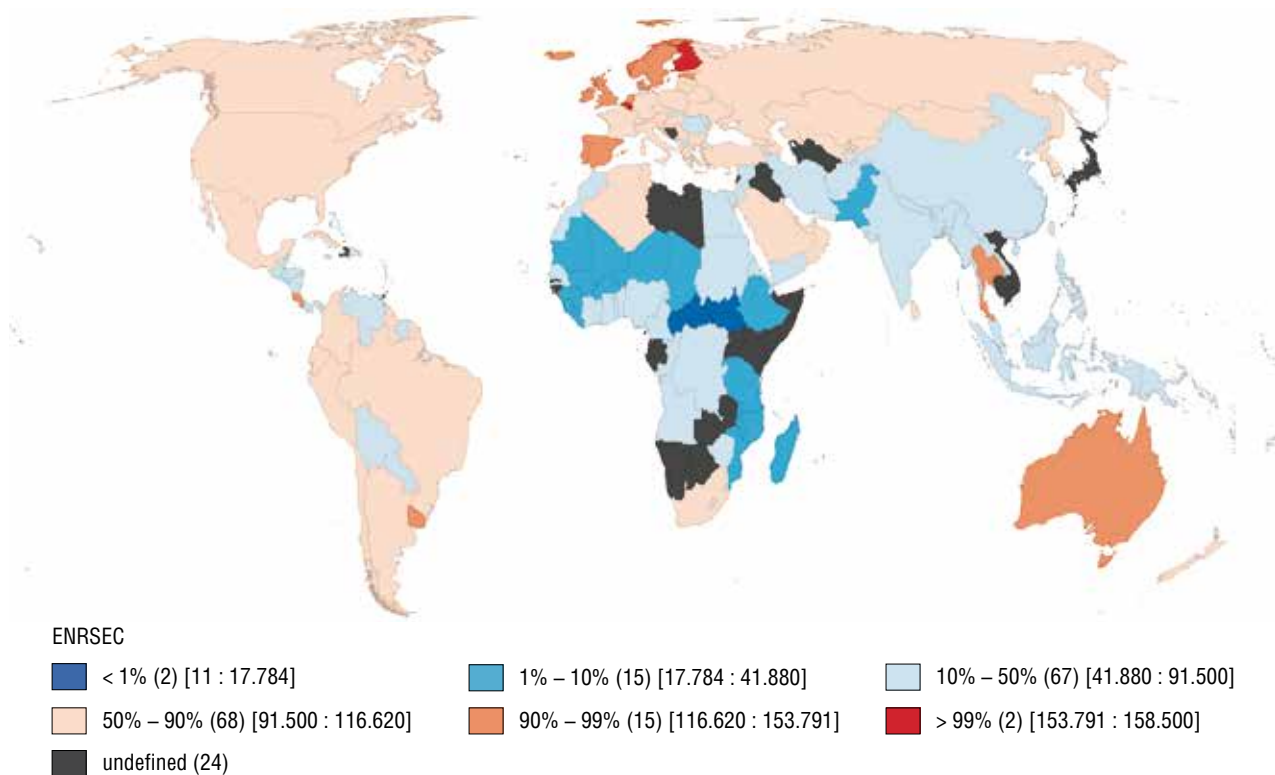


Fig. 7.2.1. Percentile cartogram for the “Secondary education enrolment” indicator

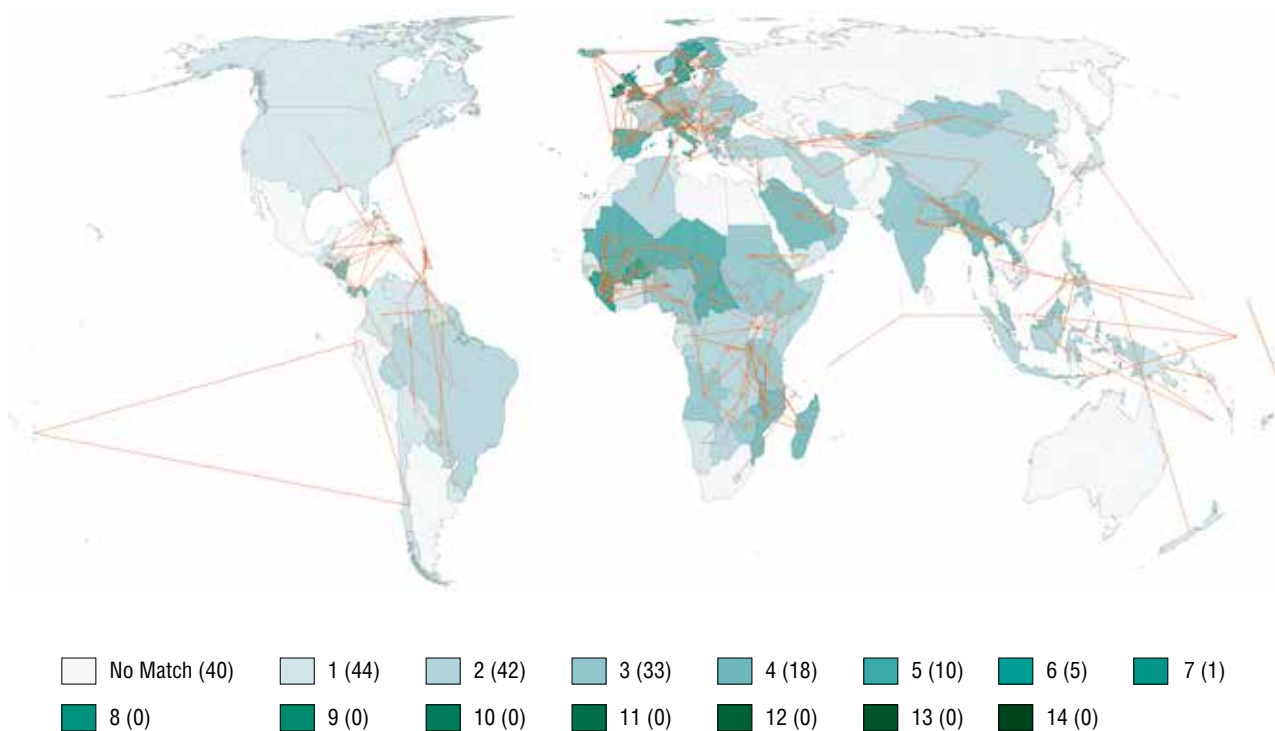


Fig. 7.2.2. Likelihood-ratio test for the “Secondary education enrolment” parameter

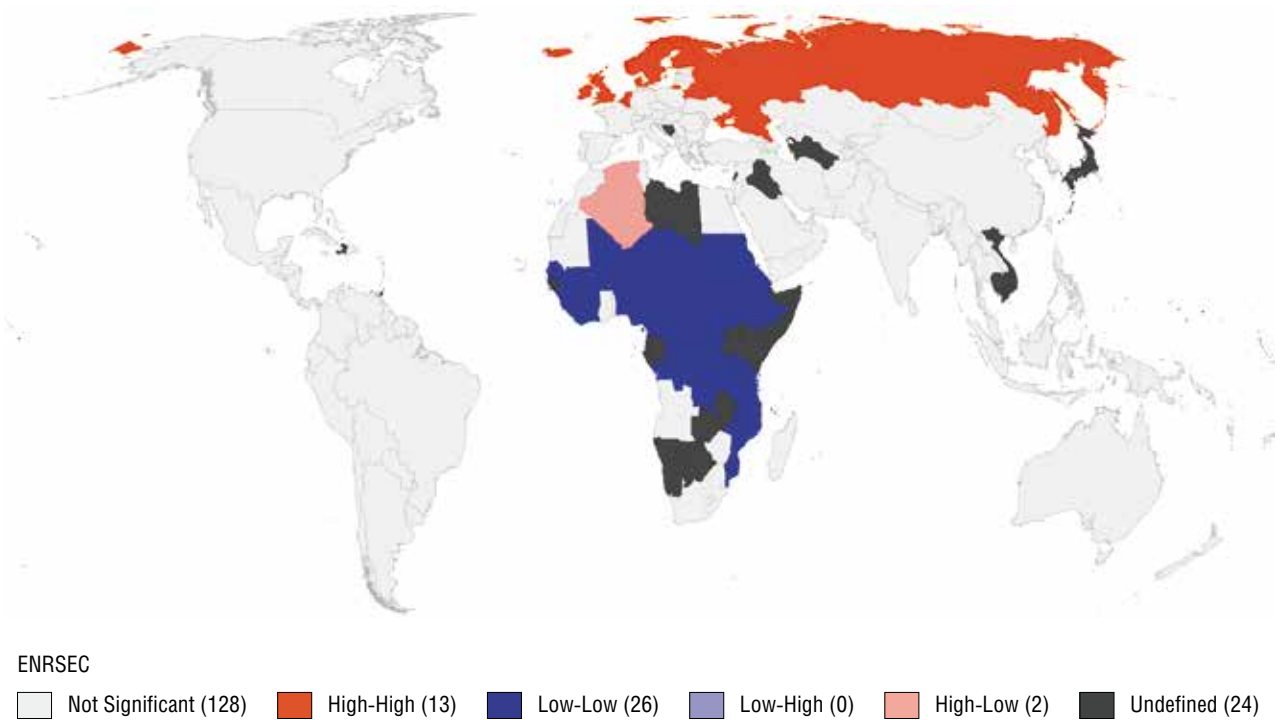


Fig.7.2.3. “Secondary education enrolment” spatial autocorrelation cartogram for the geometric neighbourhood matrix

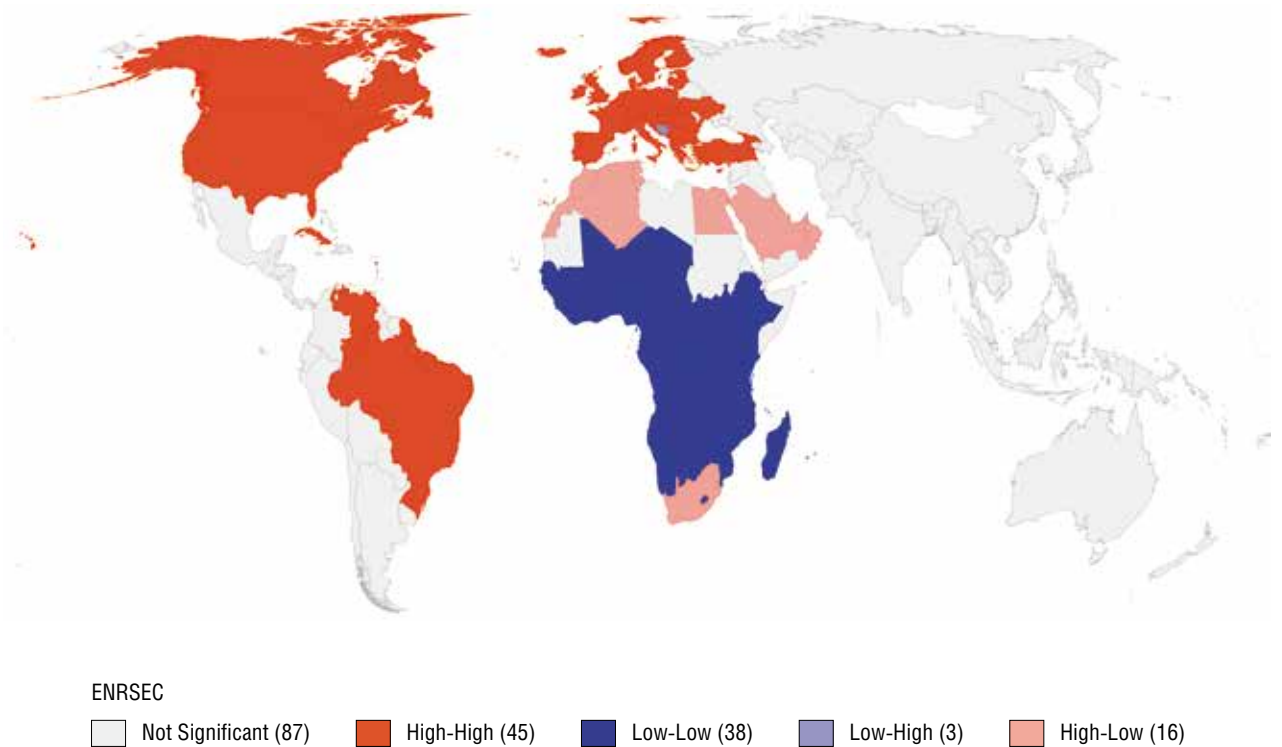


Fig. 7.2.4. “Secondary education enrolment” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.3. Tertiary education enrolment

Gross enrolment ratio in tertiary education shows how effective and balanced a higher education system is. It shows the burden on the educational system in terms of enrolling older people, and indicates the demand for higher education in a country. On average, the world's gross tertiary education enrolment is a little over 40%.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.475	0.000	0.414	0.000
Geary's C	0.534	0.000	0.583	0.000

The percentile cartogram (Fig. 7.3.1) shows that in some states, tertiary education enrolment is significantly over 100% (Greece, Turkey, Australia). A higher tertiary education ratio may emerge for different reasons, and each country has its own. For instance, high tertiary education enrolment in Greece is due to the deep employment crisis, which is forcing young people to delay entering the job market and thus continue studying, while older people re-enter the education system in order to receive new training.

Countries with low tertiary education enrolment are concentrated in Africa and South Asia. The development level and economic structure of these countries do not require many highly qualified personnel, and there is no need for widespread higher education.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 7.3.3) quite clearly shows two clusters: an African cluster with low enrolment figures and a European cluster with high enrolment figures in higher education. Sub-Saharan countries demonstrate low values for the indicator under consideration, i.e. the neighbourhood factor rings true here. The European cluster has a clearly manifested latitudinal stretch and includes Scandinavian and Baltic states, Russia, Belarus, Poland, Germany and Belgium. The neighbourhood principle proves true here, too: both these states themselves and their

Global place	Country	Indicator (%)
1	Greece	136.6
2	Turkey	113.2
3	Australia	113.1
Mean (75)	(Mauritius)	40.8448 (40.6)
Median (82)	Liechtenstein	35.6
161	Central African Republic	3.0
162	Gambia	2.7
163	Malawi	0.8

neighbours exhibit high values for the indicator under consideration. The geopolitical neighbourhood matrix cartogram also shows two spatial clusters (Fig. 7.3.4). One, a Euro-Atlantic cluster, demonstrates high tertiary education enrolment figures. Exceptions here are micro-states (Luxembourg and Liechtenstein) and Serbia (whose current pro-European leanings mean it cannot be counted as a full-fledged part of this cluster). Unlike the geographic neighbourhood matrix, the geopolitical matrix allows us to lump European countries, the United States and Canada together. Notably, despite the high enrolment figures in higher education in the USSR, there is no spatial cluster formed under the geopolitical neighbourhood matrix for the CSTO–EAEU–CIS integration group. The other cluster emerges in Africa and is formed on the basis of geopolitical alliances of the countries of Southern and West Africa that demonstrate low indicator values due to the neighbourhood factor. This cluster includes states with extremely low enrolment figures in tertiary education, such as the Central African Republic, Malawi and the Gambia.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Tertiary education enrolment” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The respective cartogram (Fig. 7.3.2) shows that, as regards enrolment in tertiary education, Europe constitutes a fairly homogeneous space. Additionally, there are two clusters with the most similar tertiary education enrolment figures in Africa: in Southern Africa and West Africa. Curiously, the Middle East and South Asia do not demonstrate any prerequisites for the formation of a node of connections for tertiary education enrolment numbers because these regions demonstrate high socioeconomic development differentiation, and this differentiation is reflected in educational systems as well. Notably, there is no connection node for tertiary education enrolments in the post-Soviet space. This may indicate that the education system is no longer a factor that ensures regional cohesion. Post-Soviet states in Eastern Europe are more integrated into the pan-European space.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Linguistic diversity	0.210	0.000	–0.464	1.025
2	Population growth	0.282	0.000	–0.521	0.963
3	Cultural solidarity	0.177	0.000	0.407	0.936
4	Ethnic fractionalization	0.185	0.000	–0.414	0.926
5	Ethnic minorities	0.083	0.000	–0.271	0.885
6	Industry	0.033	0.023	0.163	0.805
7	Economic inequality	0.124	0.000	–0.315	0.800
8	Access to electricity	0.389	0.000	0.550	0.778
9	Particulate air pollution	0.300	0.000	–0.476	0.755
10	Maternal mortality	0.412	0.000	–0.555	0.748

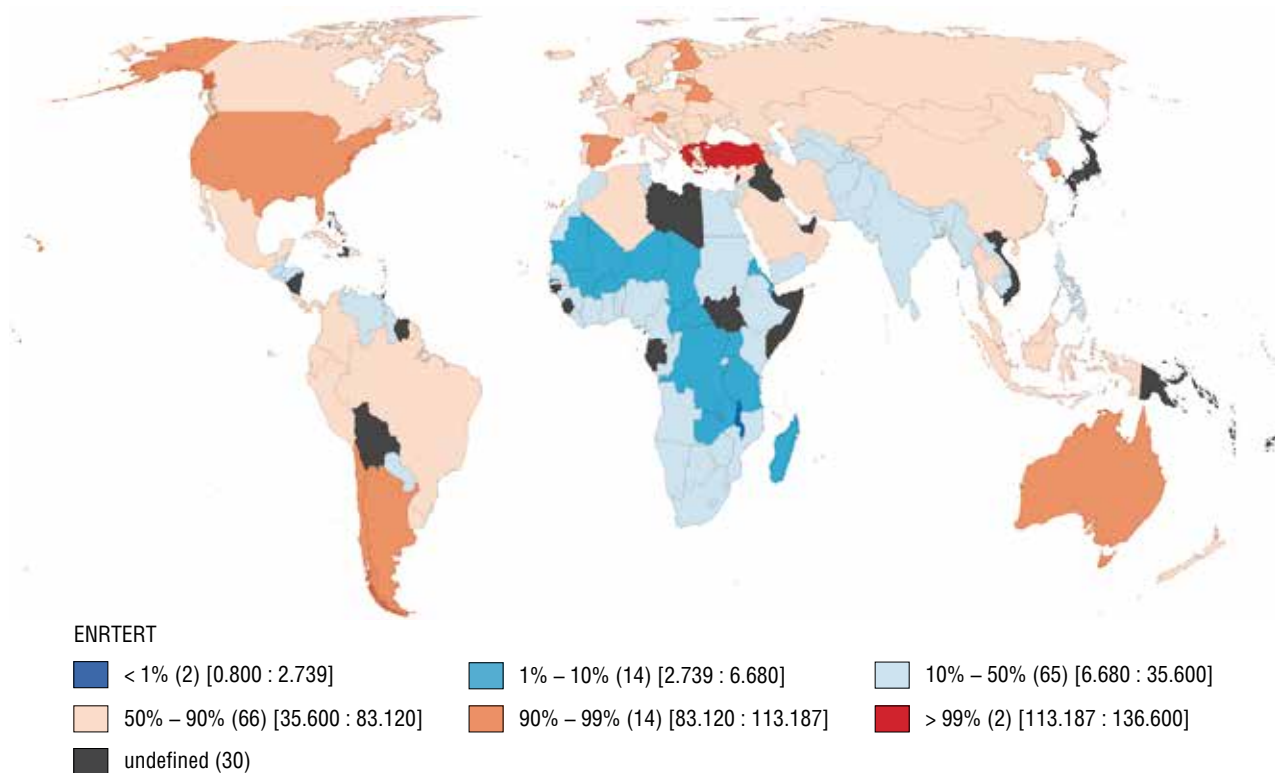


Fig. 7.3.1. Percentile cartogram for the “Tertiary education enrolment” indicator

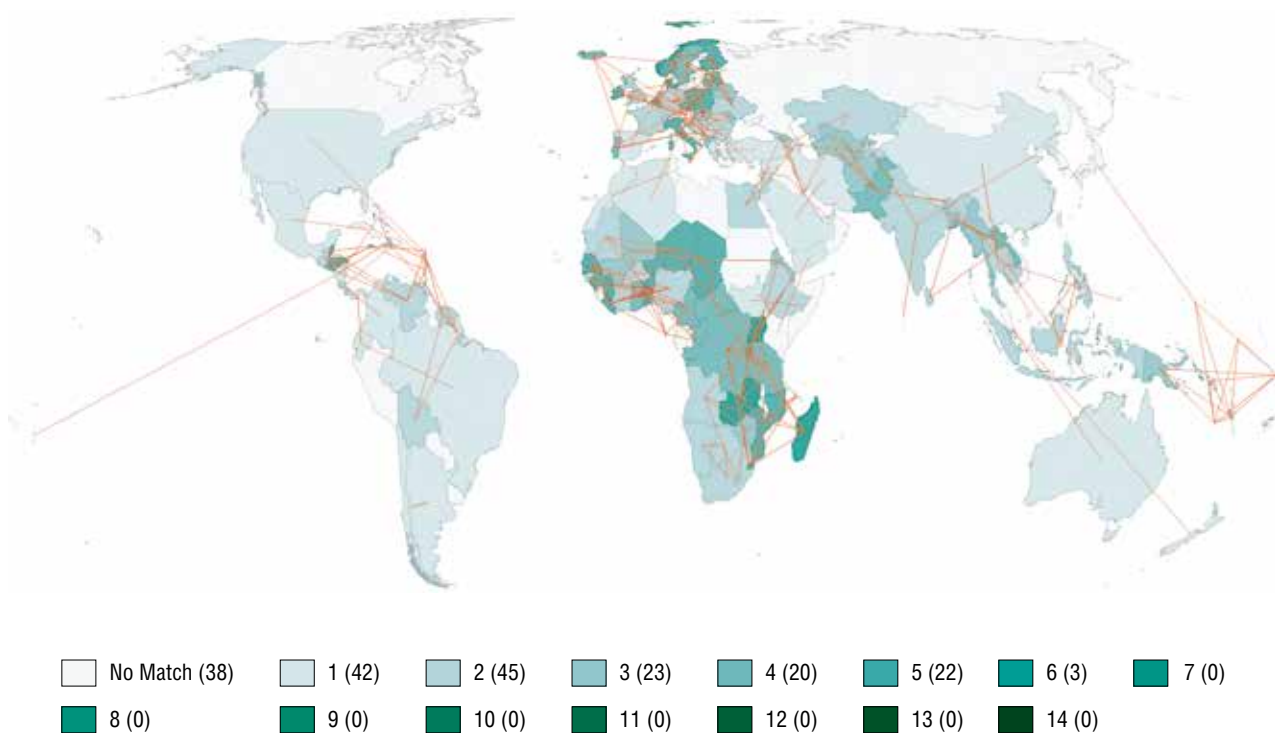


Fig. 7.3.2. Likelihood-ratio test for the “Tertiary education enrolment” parameter

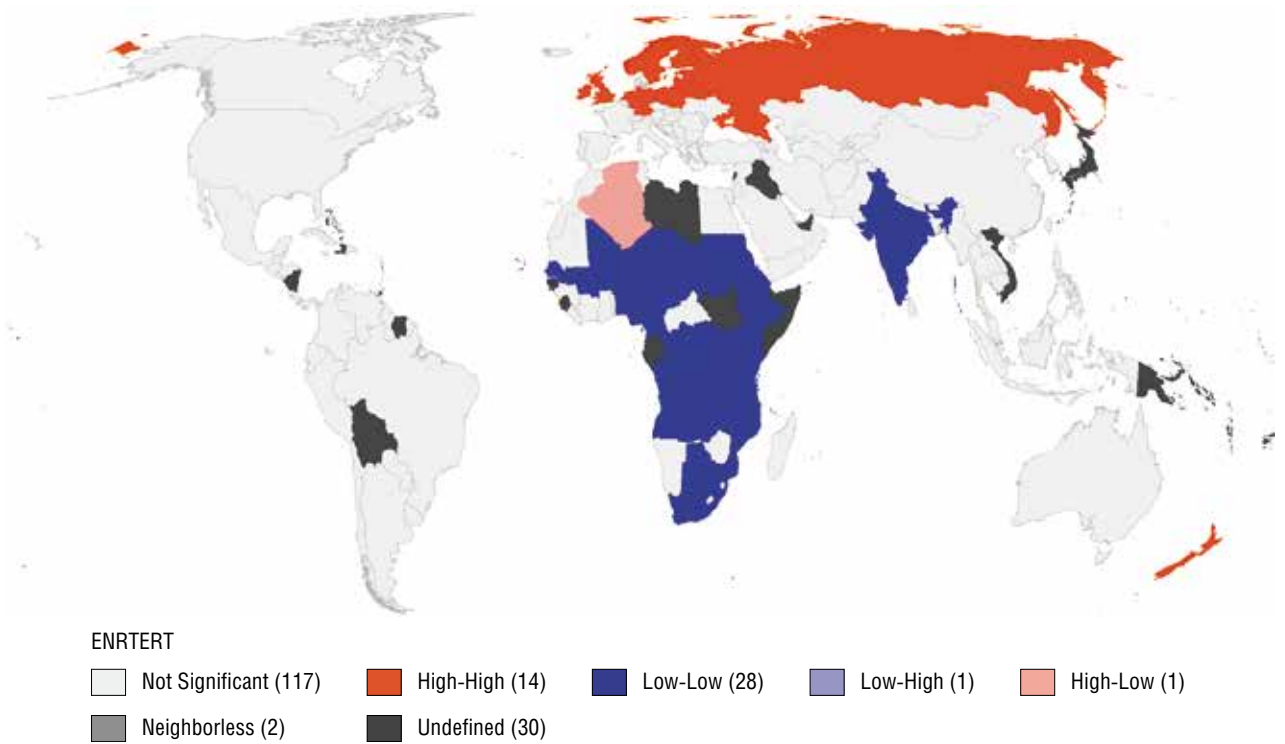


Fig. 7.3.3. “Tertiary education enrolment” spatial autocorrelation cartogram for the geometric neighbourhood matrix

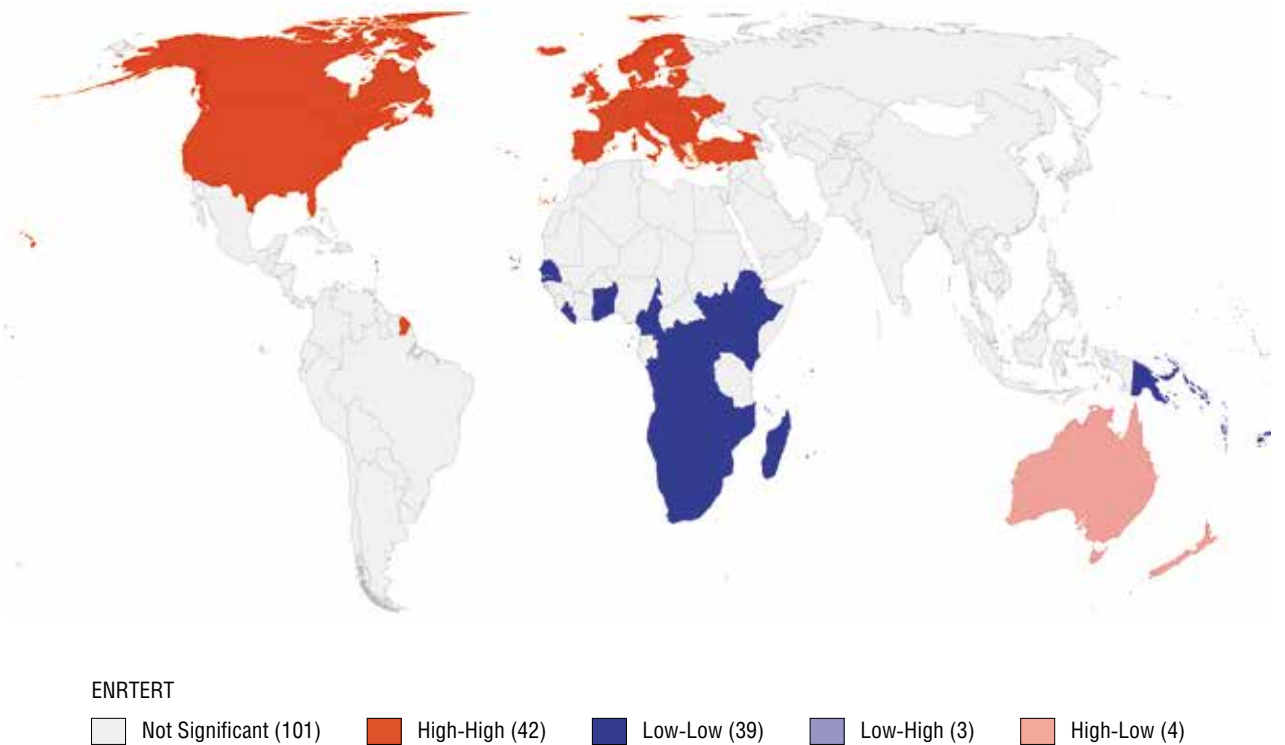


Fig. 7.3.4. “Tertiary education enrolment” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.4. Quality of school education

Expected years at school adjusted for educational results is an indicator of the effectiveness of a country's education system, since it accounts not only for years at school, but also for the results obtained as a result of the education process. This indicator is calculated by multiplying expected years at school by the ratio of international comparative studies results to 625 (the threshold where higher figures mean that learners have "very high" functional literacy).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.326	0.000	0.259	0.000
Geary's C	0.646	0.000	0.737	0.000

Countries with low socioeconomic development typically score low on the expected years at school adjusted for education results indicator. The percentile cartogram (Fig. 7.4.1) shows that most countries with low indicator values are located in Africa (moreover, with the exception of Kenya, the entire African continent belongs in the group of low or very low values). It is important to note that, in most cases, low indicator values for expected years at school adjusted for educational results, which is typical for African countries, is a consequence both of the fact that children on the continent generally do not attend school for many years (high schools are rare in many countries), and of the poor educational performance recorded in international research. Another group of states with low values for the indicator under consideration is located in South and Southeast Asia and Oceania. Most other countries demonstrate above-mean values for expected years at school controlled for education results.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix shows two large clusters (Fig. 7.4.3). The first is located in Africa and demonstrates very low expected years at school adjusted for educational results. This group includes most African states, with the exception of South Africa, Botswana,

Global place	Country	Indicator (years)
1	Singapore	12.8
2–6	Finland, Estonia, Canada, Japan, South Korea	11.7
7–8	Sweden, Ireland	11.6
Median (84–85)	(Saudi Arabia, Brazil)	7.850 (7.9)
Mean (86–87)	(Indonesia, Bosnia and Herzegovina)	7.7665 (7.8)
168	Mali	2.6
169	South Sudan	2.5
170	Liberia	2.2

Angola, and several states of Central and West Africa. The second cluster is characterized by high indicator values, a consequence of high economic wellbeing, the availability of social benefits to the population, and an established culture of receiving a high-quality education. This cluster includes Europe, Russia and Japan.

The geopolitical neighbourhood matrix cartogram (Fig. 7.4.4) shows three large spatial clusters whose composition is somewhat different from the results obtained using the geometric neighbourhood matrix. The African cluster, which is characterized by low expected years at school adjusted for educational results, includes all sub-Saharan states with the exception of Sudan, Chad and the Central African Republic. Additionally, Kenya does not fit the pan-African pattern since its values for the expected years at school adjusted for educational results indicator are significantly higher than those of its neighbours. The European cluster of countries, which demonstrates high values of the indicator under consideration, extends to the countries of the Balkan Peninsula (with the exception of North Macedonia, where the indicator values are lower than those of its neighbours), Turkey and Georgia. Unlike on the geometric neighbourhood matrix cartogram, this cluster does not include Russia and Japan. Additionally, North America has a cluster that includes the United States and Canada, which also have high expected years at school adjusted for educational results.

A comparison of cartograms for geometric and geopolitical neighbourhood matrices leads us to conclude that the geopolitical matrix offers a better representation of the structure of the modern world.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Quality of school education” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The cartogram (Fig. 7.4.2) clearly shows four groups of connections: Latin America; sub-Saharan Africa; Europe and Canada; and South and Southeast Asia. Curiously, the cartogram shows no connections between the United States and other states.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Light pollution	0.037	0.013	0.258	1.782
2	Public organizations	0.024	0.047	0.188	1.487
3	Industry	0.043	0.007	0.253	1.481
4	IMF voting power	0.102	0.000	0.362	1.286
5	Services sector	0.046	0.007	0.242	1.276
6	Unused export potential	0.105	0.000	0.332	1.047
7	Import	0.136	0.000	0.367	0.992
8	Export	0.158	0.000	0.395	0.985
9	Ethnic fractionalization	0.202	0.000	-0.416	0.856
10	Population growth	0.348	0.000	-0.546	0.856

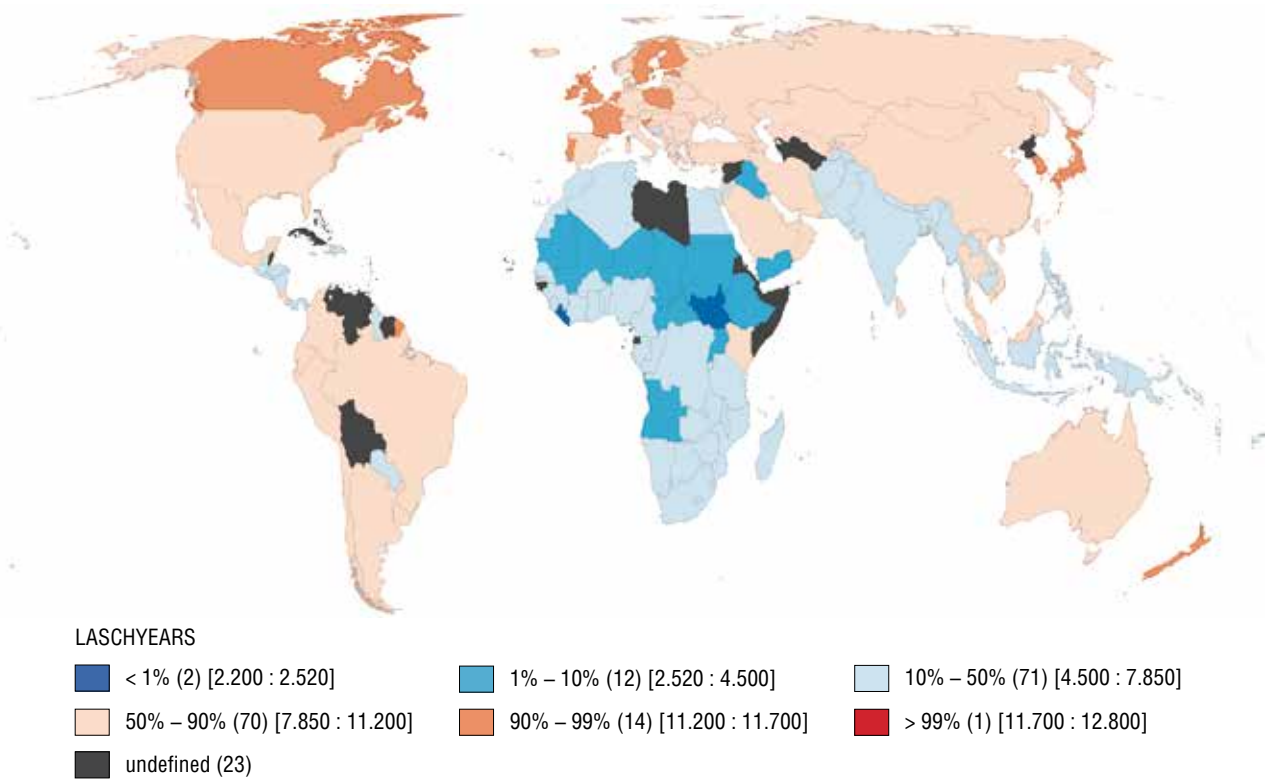


Fig. 7.4.1. Percentile cartogram for the “Quality of school education” indicator

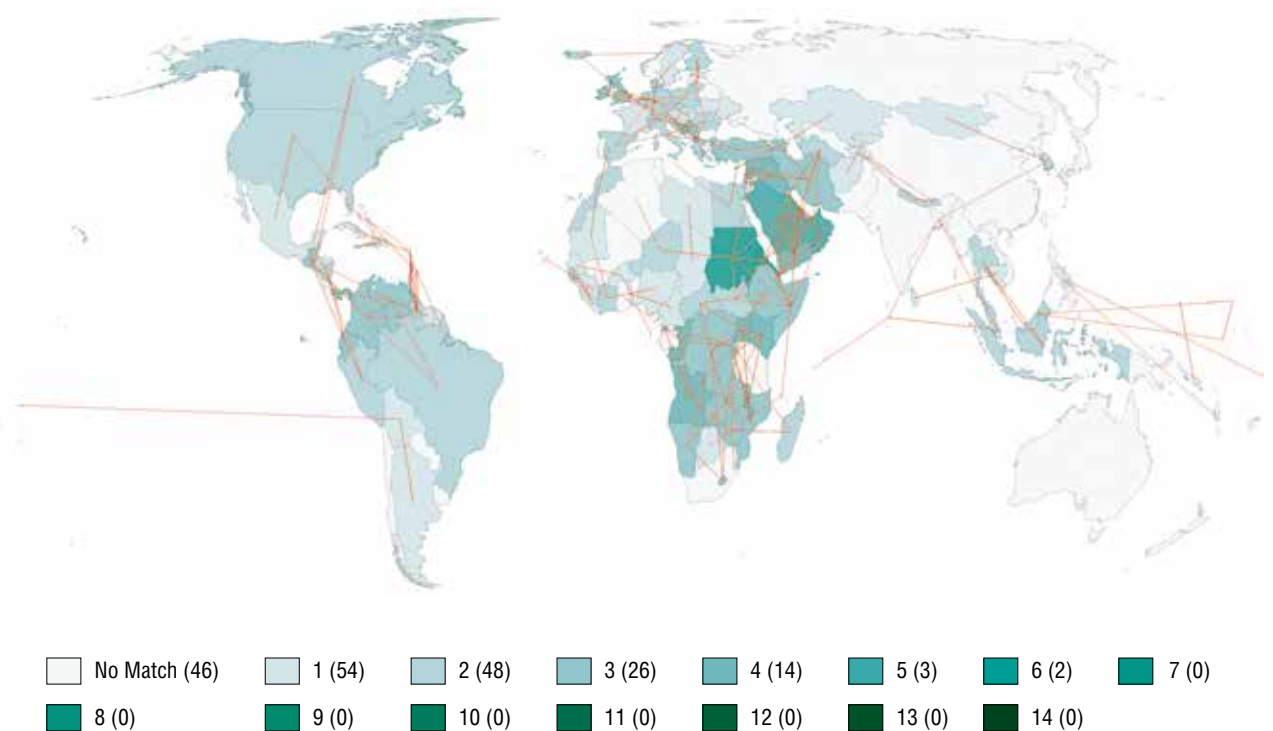


Fig. 7.4.2. Likelihood-ratio test for the “Quality of school education” parameter

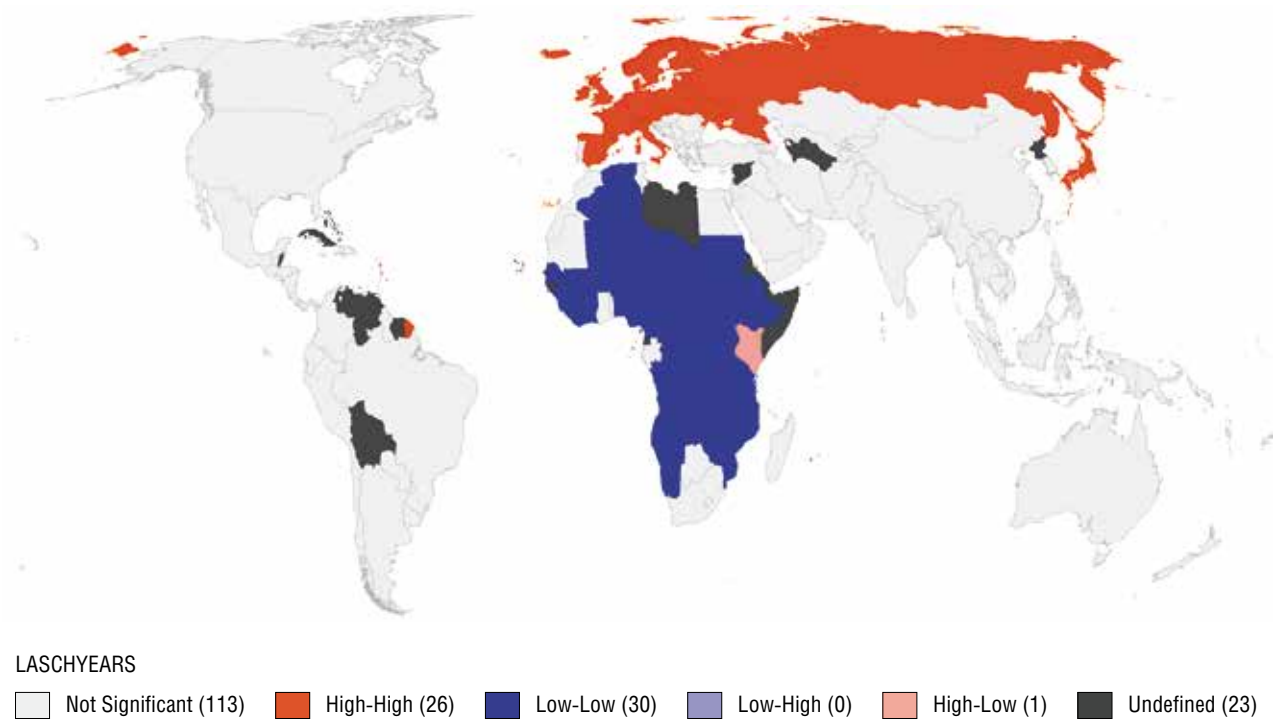


Fig. 7.4.3. “Quality of school education” spatial autocorrelation cartogram for the geometric neighbourhood matrix

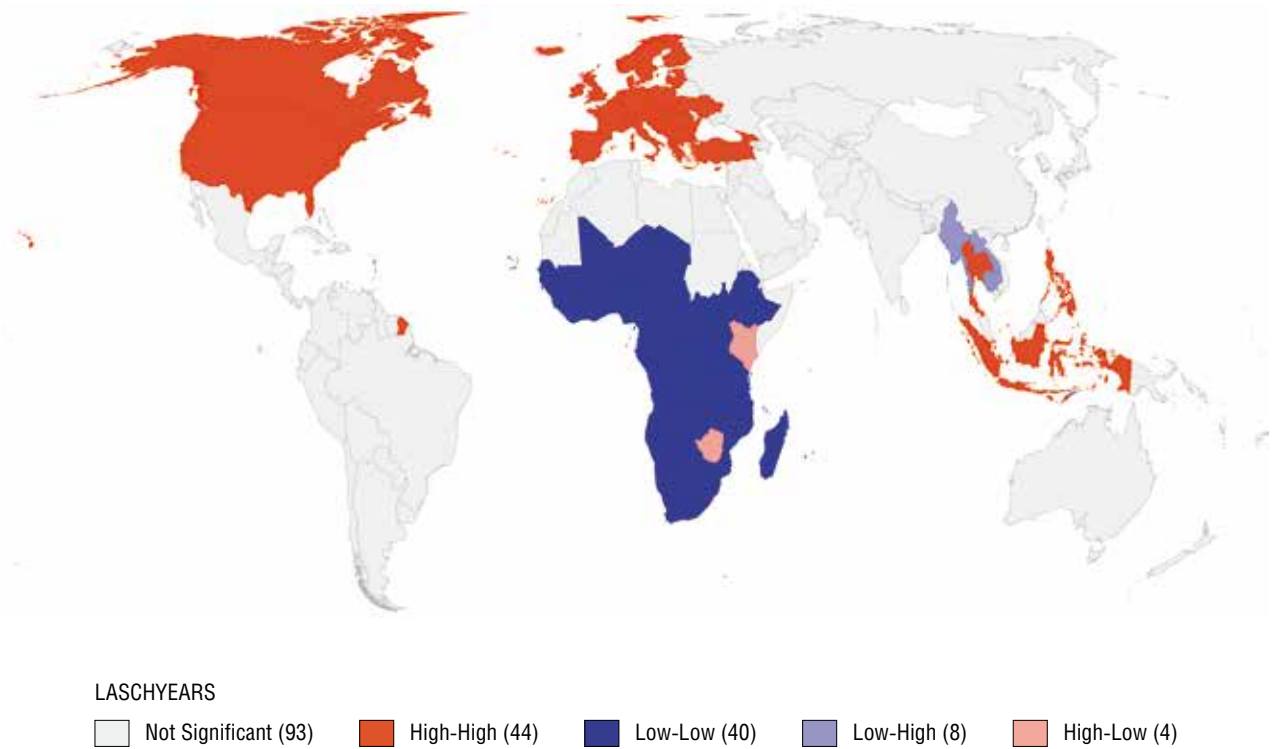


Fig. 7.4.4. “Quality of school education” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.5. Years at school

Expected years at school is one of the basic indicators assessing the development of a national education system. The higher the value of this indicator, the higher the level of education of graduates and, accordingly, the higher their chances of acquiring skills that are in demand on the job market. Expected years at school is calculated as the average number of years spent on education by people aged 25 and over. Information on standard school years in a given country is used for the calculations.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.482	0.000	0.387	0.000
Geary's C	0.518	0.000	0.610	0.000

High values for the expected years at school indicator are, as a rule, typical for countries with a high level of socioeconomic wellbeing. The percentile cartogram (Fig. 7.5.1) shows that most states with low indicator values are concentrated in Africa (with the exception of South Africa and Botswana). High indicator values are typical for countries of Europe, North America, part of South America, and the Middle East. Notably, higher indicator values are also observed in many countries of the post-Soviet space (including Russia and also Central Asian states).

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix shows three stable clusters (Fig. 7.5.3). The first is located in Africa and includes a large number of sub-Saharan states. Amid low economic development and a poorly developed social benefits system, these countries demonstrate extremely low scores when it comes to expected years at school. The second low-value cluster includes two large Asian countries, India and Thailand. The low values exhibited by these countries are due to major educational disparities (both states have world-class educational organizations with an international competitive edge, but they are only accessible to the limited part of the population). Finally, a large cluster

Global place	Country	Indicator (years)
1	Germany	14.1
2–3	US, Switzerland	13.4
4	Canada	13.3
Median (93–95)	Ecuador, Uruguay, Grenada	8.8
Mean (98–99)	(Mexico, Saint Vincent and the Grenadines)	8.6075 (8.6)
184	Mali	2.4
185	Niger	2.0
186	Burkina Faso	1.6

of countries with high indicator values includes most developed countries in Europe (Spain and Portugal constitute somewhat inexplicable exceptions here), Russia and Canada.

The geopolitical neighbourhood matrix cartogram (Fig. 7.5.4) shows four clusters that largely duplicate the findings for the geometric neighbourhood matrix, but have several significance differences in the composition of these clusters. Africa has two clusters with low values for the expected years at school indicator. One is located in the west of the continent (countries to the south and southeast of Algeria), and the second is in the east of Africa (Ethiopia, South Sudan, Uganda, Kenya and Tanzania). India and Bangladesh (with the latter taking the place of Thailand compared to the findings for the geometric neighbourhood matrix) form another cluster with low values for the indicator under consideration. A cluster of states with high values for the expected years at school indicator includes more countries than the cluster produced by the geometric neighbourhood matrix: all the countries of Europe, the Balkan Peninsula, North America and Central Asia, as well as Russia. Characteristically, this cluster does not include Turkey, whose values for the indicator under consideration are significantly lower and are consistent with the countries of the Middle East.

A comparison of cartograms for the geometric and geopolitical neighbourhood matrices leads to the conclusion that the geopolitical matrix offers a better representation of the structure of the modern world.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Years at school” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The cartogram (Fig. 7.5.2) clearly shows the integration of European and North American states, which have similar expected years of schooling. Additionally, we can clearly identify a cluster of South American countries, as well as an African cluster and an Asian cluster.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	IMF voting power	0.081	0.000	0.290	1.038
2	Linguistic diversity	0.182	0.000	-0.429	1.012
3	Ethnic minorities	0.071	0.000	-0.261	0.966
4	Women in politics	0.034	0.012	0.181	0.958
5	Light pollution	0.030	0.021	0.168	0.946
6	Inbound tourism	0.086	0.000	0.277	0.890
7	Cultural solidarity	0.115	0.000	0.312	0.847
8	Export	0.101	0.000	0.291	0.838
9	Services sector	0.039	0.010	0.180	0.824
10	Import	0.088	0.000	0.265	0.801

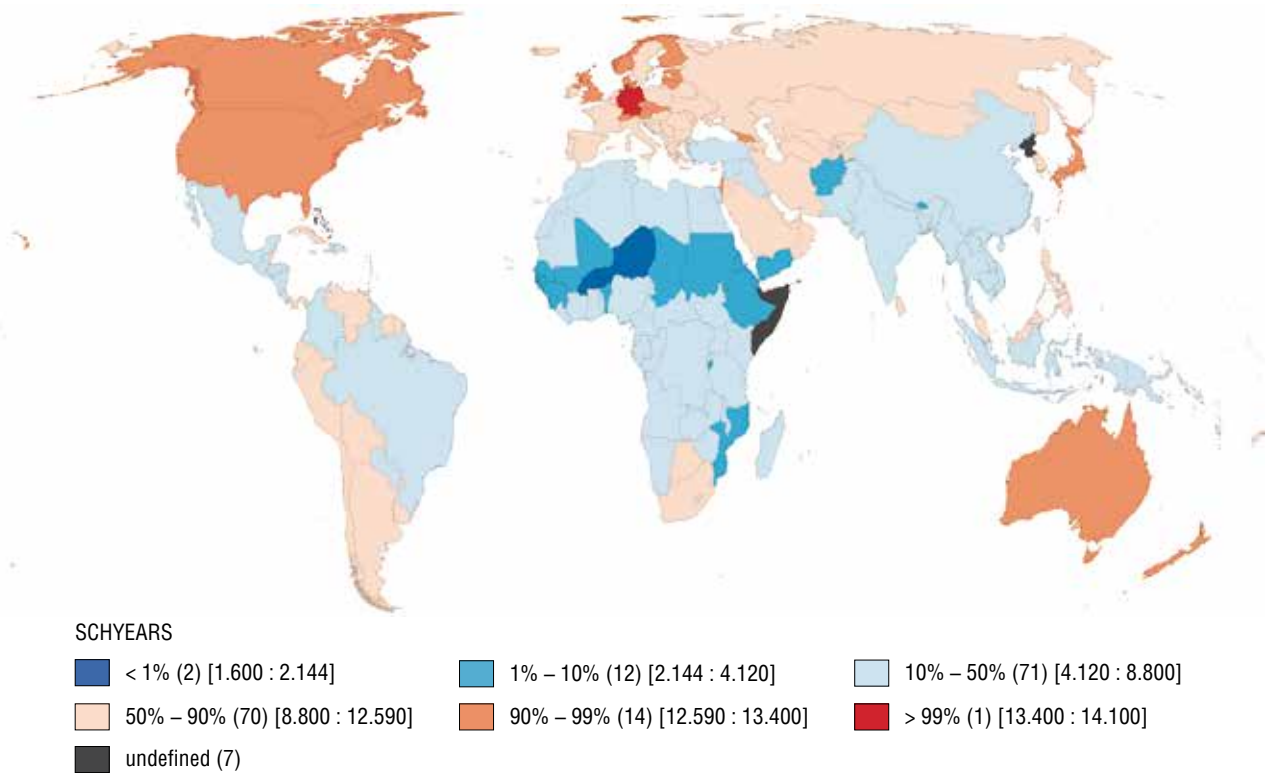


Fig. 7.5.1. Percentile cartogram for the “Years at school” indicator

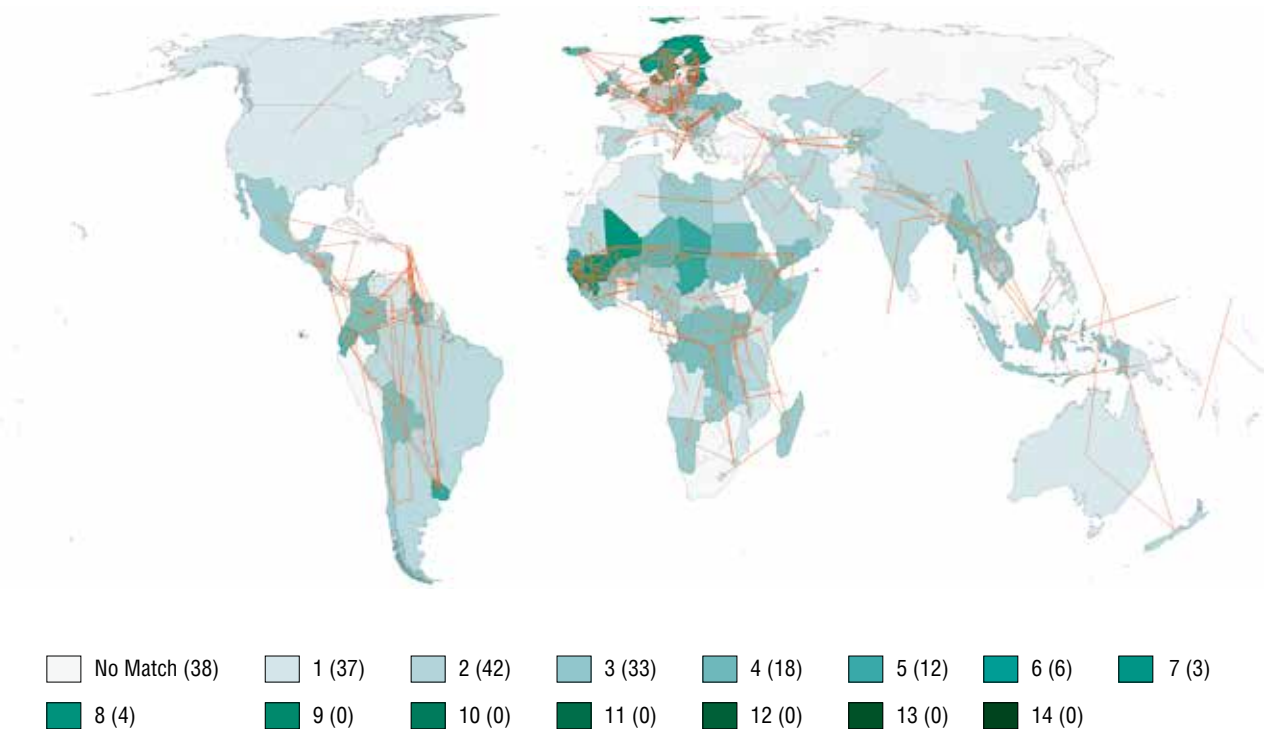


Fig. 7.5.2. Likelihood-ratio test for the “Years at school” parameter

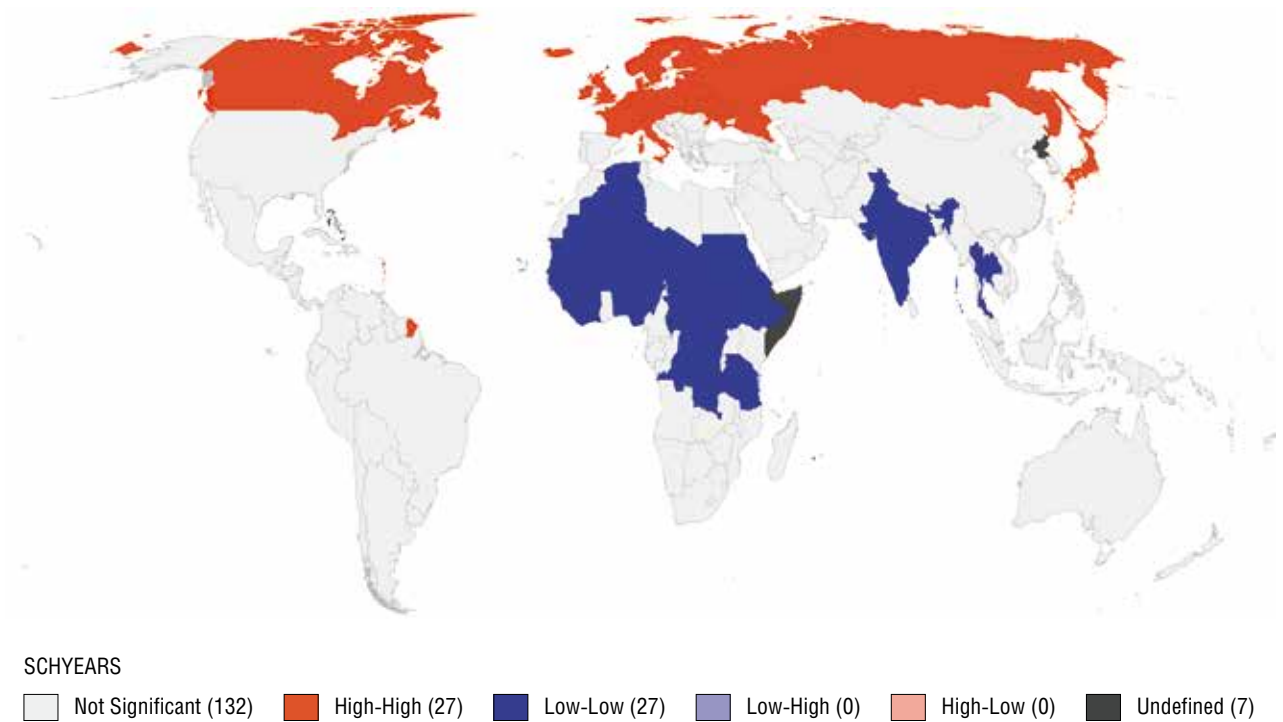


Fig. 7.5.3. “Years at school” spatial autocorrelation cartogram for the geometric neighbourhood matrix

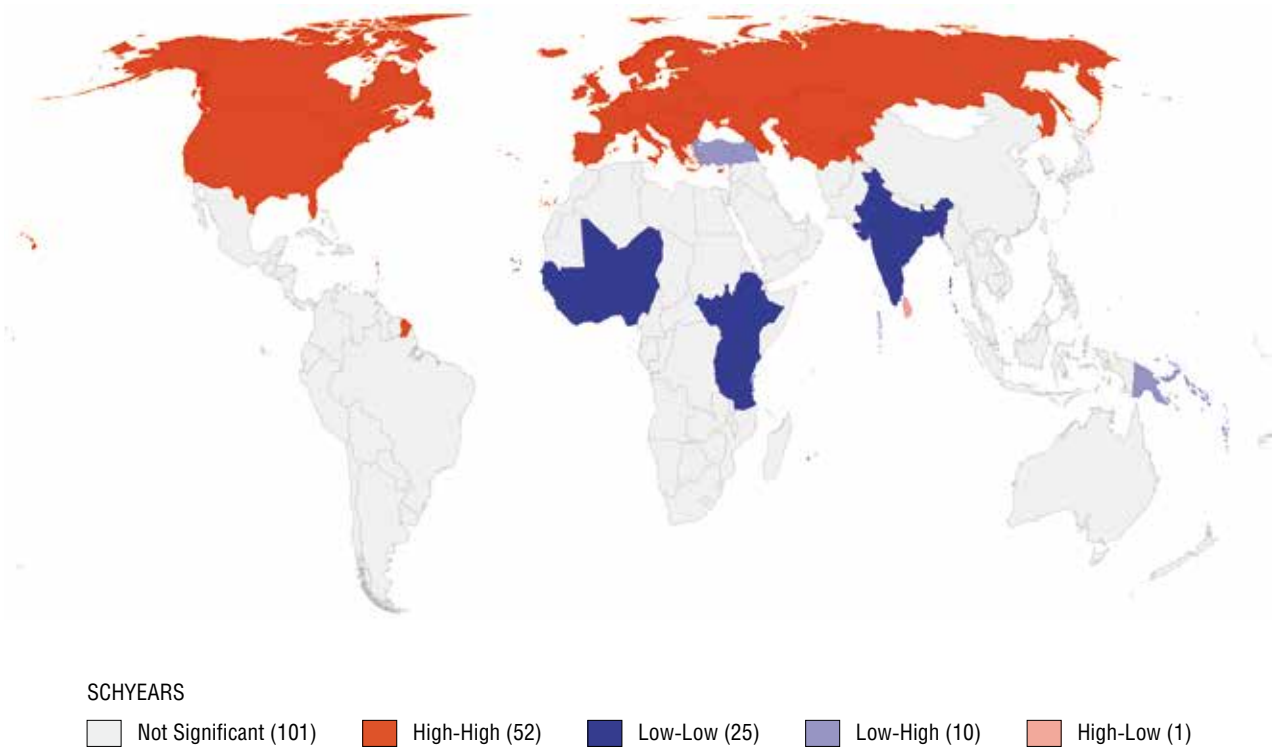


Fig. 7.5.4. “Years at school” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.6. Primary school dropouts

The percentage of primary school dropouts is an indicator that characterizes not so much the educational system as the degree of social isolation of children due to low levels of socioeconomic development. Poverty is the greatest obstacle to education. Additionally, children living in conditions of a military conflict or facing discrimination based on ethnicity, gender or disability are often not able to attend primary school. On average, the percentage of primary school dropouts exceeds 15% worldwide.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.396	0.000	0.379	0.000
Geary's C	0.602	0.000	0.618	0.000

The percentile cartogram (Fig. 7.6.1) shows that the lowest percentages of primary school dropouts are observed in developed countries. The leader here is Japan, which does not have any primary school dropouts at all. Low percentages of dropouts (less than 0.2%) are observed in Spain, Turkey, Italy, the United Kingdom, etc. The institutional context of the functioning of the educational is important for a proper interpretation of this indicator's distribution. In a number of countries (primarily those with a high level of socioeconomic development), primary education is mandatory for everyone, therefore, dropout percentages are low. Countries with high values for the primary school dropouts indicator are concentrated in Africa, South Asia, and the north of South America.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix shows two clusters (Fig. 7.6.3). Individual states of Central and Northern Europe, as well as Russia, form a cluster with low percentages of primary school dropouts. Similar to other indicators of education system development, an entirely "negative" cluster emerges in Africa. Most countries on the continent demonstrate high percentages of primary school dropouts. Notably, the neighbourhood principle in this context clearly

Global place	Country	Indicator (%)
1	Sierra Leone	75.8
2	Chad	71.4
3	Angola	68.1
Mean (58–59)	(Eswatini, Djibouti)	15.6565 (15.6)
Median (80–81)	Kenya, Morocco	7
155–158	Finland, Denmark, UK, Italy	0.2
159–160	Spain, Turkey	0.1
161	Japan	0

does not work for Algeria, Tanzania and Kenya. Compared to their neighbours, these states demonstrate relatively low dropout percentages.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 7.6.4) also shows two clusters: a European cluster and an African cluster. In addition to European countries as such, the cluster with low dropout percentages includes Russia and the countries of the South Caucasus. This variant of the European cluster is far broader than the one for the geometric neighbourhood matrix: Russia and its European post-Soviet neighbours turned out to be far closer to the Euro-Atlantic bloc than to its Asian partners. This is probably due to the relative economic prosperity of the population, common approaches to the provision of education (free, universal and mandatory) and the high sociocultural significance attached to education in the countries that form the regional geopolitical communities. Sub-Saharan countries form an African cluster with high dropout percentages. Compared to the geometric neighbourhood matrix, this cluster expands somewhat (mostly towards the south) under the geopolitical neighbourhood matrix. This indicates that integration alliances in Africa span states with homogeneously functioning education systems.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Primary school dropouts” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The relevant cartogram (Fig. 7.6.2) clearly shows a European node of connections emerging for the percentage of dropouts indicator. Two relatively dense nodes are also observed in the west and southeast of Africa. Notably, countries of the Arab world do not form a node of connections. Apparently, differentiation in the level of economic development between the countries of North Africa and the Middle East is so high it stands in the way of regional integration.

The post-Soviet space also appears disjointed from the point of view of educational systems. This may indirectly indicate that the sociocultural aspect, namely, education in this case, ceases to be a force of cohesion for the states of the former USSR.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Light pollution	0.036	0.018	-0.236	1.547
2	Cultural solidarity	0.139	0.000	-0.378	1.028
3	IMF voting power	0.053	0.003	-0.232	1.016
4	Ethnic minorities	0.058	0.003	0.240	0.993
5	Industry	0.050	0.006	-0.222	0.986
6	Availability of electricity	0.122	0.000	-0.342	0.959
7	Healthcare spending	0.112	0.000	-0.312	0.869
8	Ethnic fractionalization	0.180	0.000	0.391	0.849
9	Highly wealthy population	0.129	0.000	0.328	0.834
10	Linguistic diversity	0.213	0.000	0.421	0.832

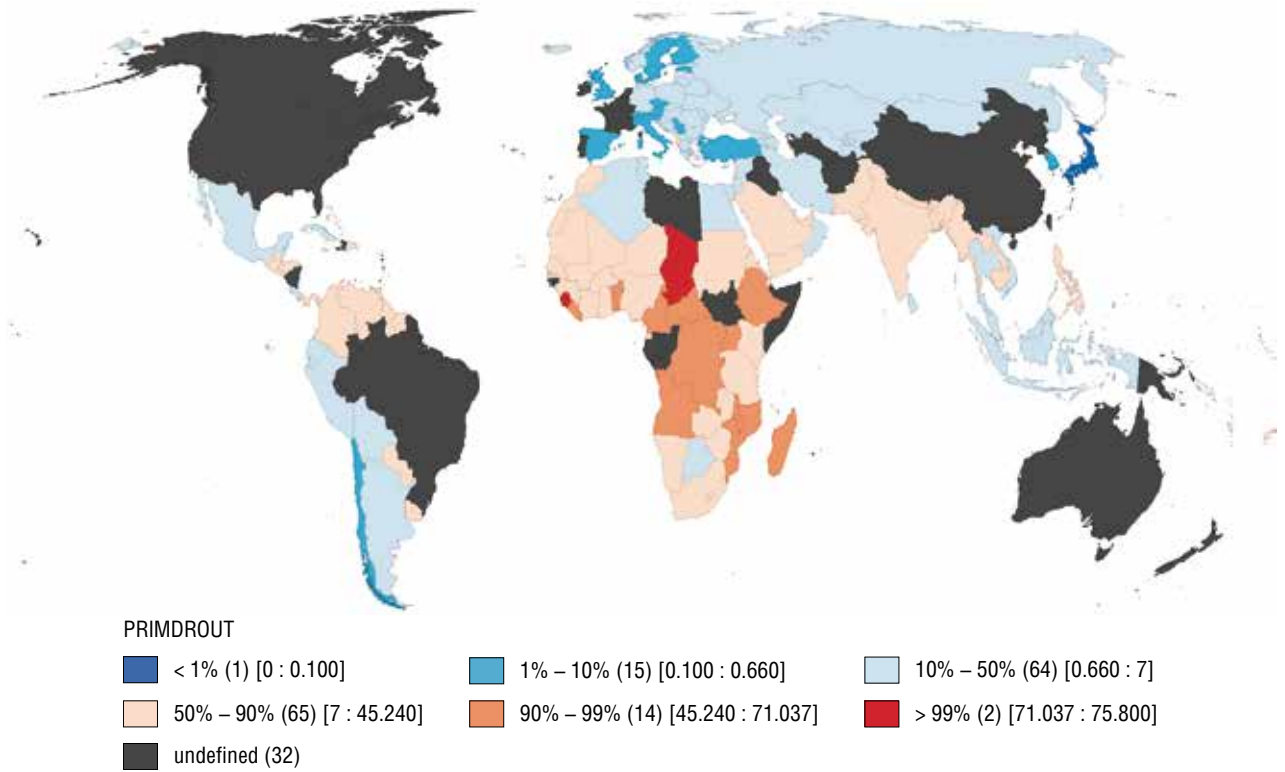


Fig. 7.6.1. Percentile cartogram for the “Primary school dropouts” indicator

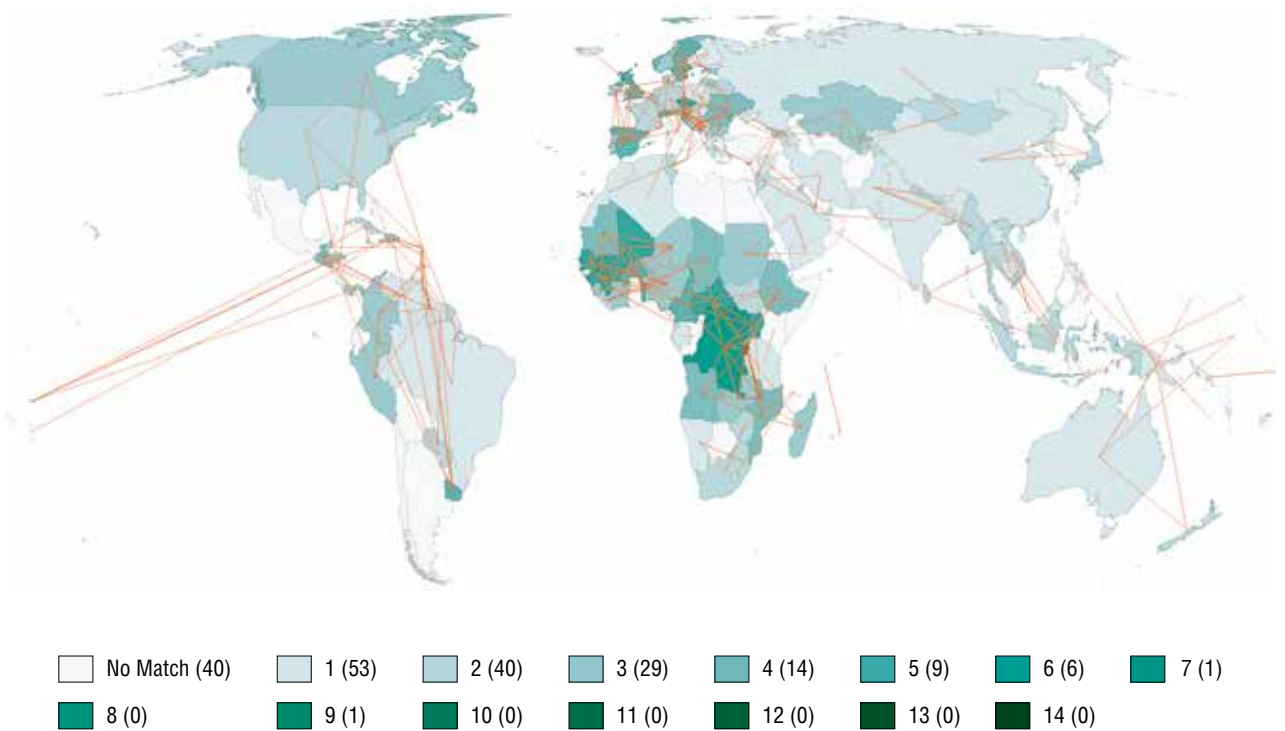


Fig. 7.6.2. Likelihood-ratio test for the “Primary school dropouts” parameter

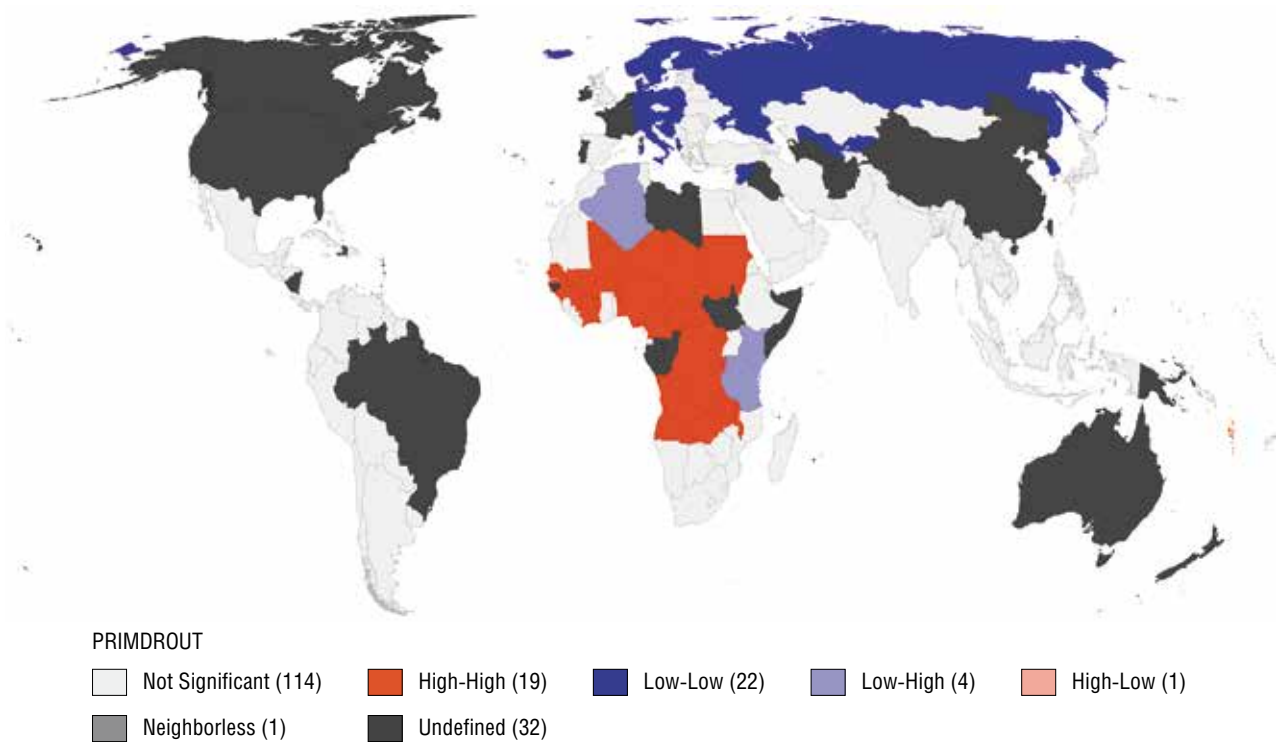


Fig. 7.6.3. “Primary school dropouts” spatial autocorrelation cartogram for the geometric neighbourhood matrix

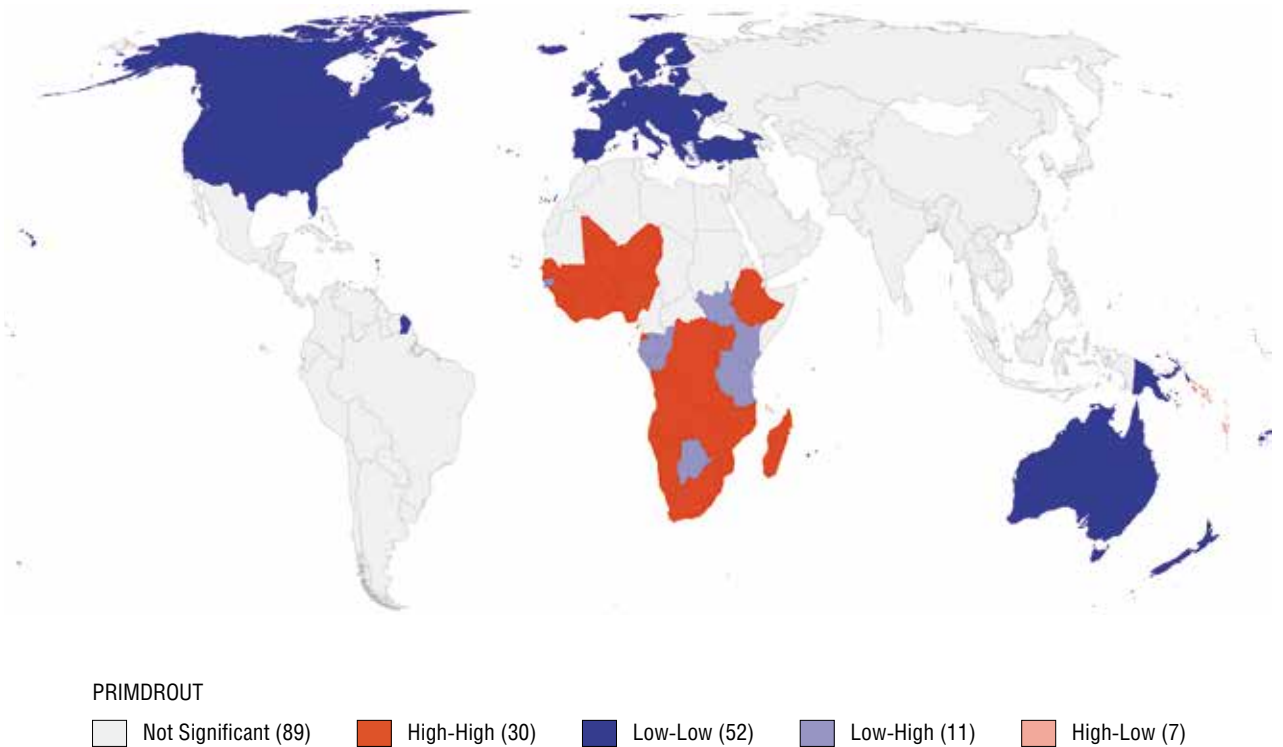


Fig. 7.6.4. “Primary school dropouts” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.7. Education spending

Education spending to GDP ratio illustrates the role of education as a political priority.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.199	0.000	0.105	0.000
Geary's C	0.790	0.000	0.890	0.000

Countries demonstrate major divergences in their education spending to GDP ratios. In relative figures, countries with high education spending earmark, on average, five times more for education than countries with low spending. The percentile cartogram (Fig. 7.7.1) shows that high education spending is typical for the countries of Northern Europe (Norway, Denmark, Sweden and Finland), where education system development is a key priority of government policies. However, due to the relatively small size of its economy, the absolute leader for this indicator is Lesotho.

Similarly, the minimal GDP percentage spent on education is demonstrated by countries with entirely different levels of economic development. The last place in the ranking is shared by the Democratic Republic of the Congo and Monaco.

Monaco has a small percentage of children (the key beneficiary of education systems). Additionally, for reasons of its size and historical and political context, Monaco is partially integrated into the education systems of its neighbours, primarily France. It is also important to note that governmental spending may be lower in those countries where the private sector has a large share in overall education funding.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Both the spatial autocorrelation cartogram and the Likelihood-ratio test show high spatial heterogeneity of education spending expressed as GDP percentage.

The spatial autocorrelation cartogram for the geometric matrix (Fig. 7.7.3) shows only one cluster, made up of Scandinavian countries. A large role in the economies of these countries is played by their highly

Global place	Country	Indicator (% of the GDP)
1	Lesotho	8.0
2	Norway	7.9
3	Denmark	7.8
Mean (56–58)	(Colombia, Vanuatu, Mexico)	4.5223 (4.5)
Median (56–58)	Colombia, Vanuatu, Mexico	4.5
109	Myanmar	2.1
110	Papua New Guinea	2.0
111–112	Monaco, Democratic Republic of the Congo	1.5

developed public services sector, including education services, which ensures a high quality of life for the population. It is important to note that Scandinavian states actively cooperate in education. For instance, they jointly fund regional mobility programmes for school and university students, school teachers and university faculty. While shared cultural and historical roots are a big reason why education integration continues in Northern Europe, there are also clear pragmatic objectives to this cooperation. The aging population and low birth rates present the countries with the urgent task of developing and stimulating the job market. This task is solved, among other things, by shaping and developing a common educational space.

Since there is no data for many countries, originally, the spatial autocorrelation cartogram for the geopolitical matrix revealed no clusters at all. To offset this problem, we created a spatial autocorrelation cartogram for the geopolitical matrix, substituting zero for those countries where the relevant statistics were unavailable (Fig. 7.7.4). This cartogram shows the Euro-Atlantic cluster, a staple for education-related indicators. Originally, the cluster did not show up, as there was no data for some regionally important countries (the United States, Canada, Turkey, Greece). On the modified geopolitical neighbourhood matrix cartogram, states with no data form sub-clusters of “errors” with low values for the indicator under consideration (light-blue on the spatial autocorrelation cartogram). The Euro-Atlantic cluster (or, in this case, its truncated European version) is formed by highly developed states that traditionally focus on developing their education systems as they both have the requisite economic resources and understand the fundamental importance of education for society’s development.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Education spending” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The relevant cartogram (Fig. 7.7.2) shows that a common node of connections emerges in Europe for government education spending. We should also note that the Middle East appears to be fairly homogeneous for this indicator at least: the cartogram representing the test’s findings shows prerequisites for forming a node of connections there. This indicator’s spatial distribution is so heterogeneous that other nodes of connections are not identified. For instance, there is no African cluster, which typically shows up for education-related indicators.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Tertiary education enrolment	0.063	0.010	0.242	0.930
2	Women in politics	0.105	0.000	0.298	0.846
3	Regional trade agreements	0.054	0.014	0.209	0.809
4	Passport power	0.086	0.002	0.248	0.715
5	Elderly population	0.055	0.014	0.186	0.629
6	Petrol prices	0.122	0.000	0.274	0.615
7	Maternal mortality	0.056	0.013	-0.184	0.605
8	Alcohol consumption	0.039	0.038	0.152	0.592
9	Marriage	0.052	0.017	-0.169	0.549
10	Loans to domestic companies	0.157	0.000	0.290	0.536

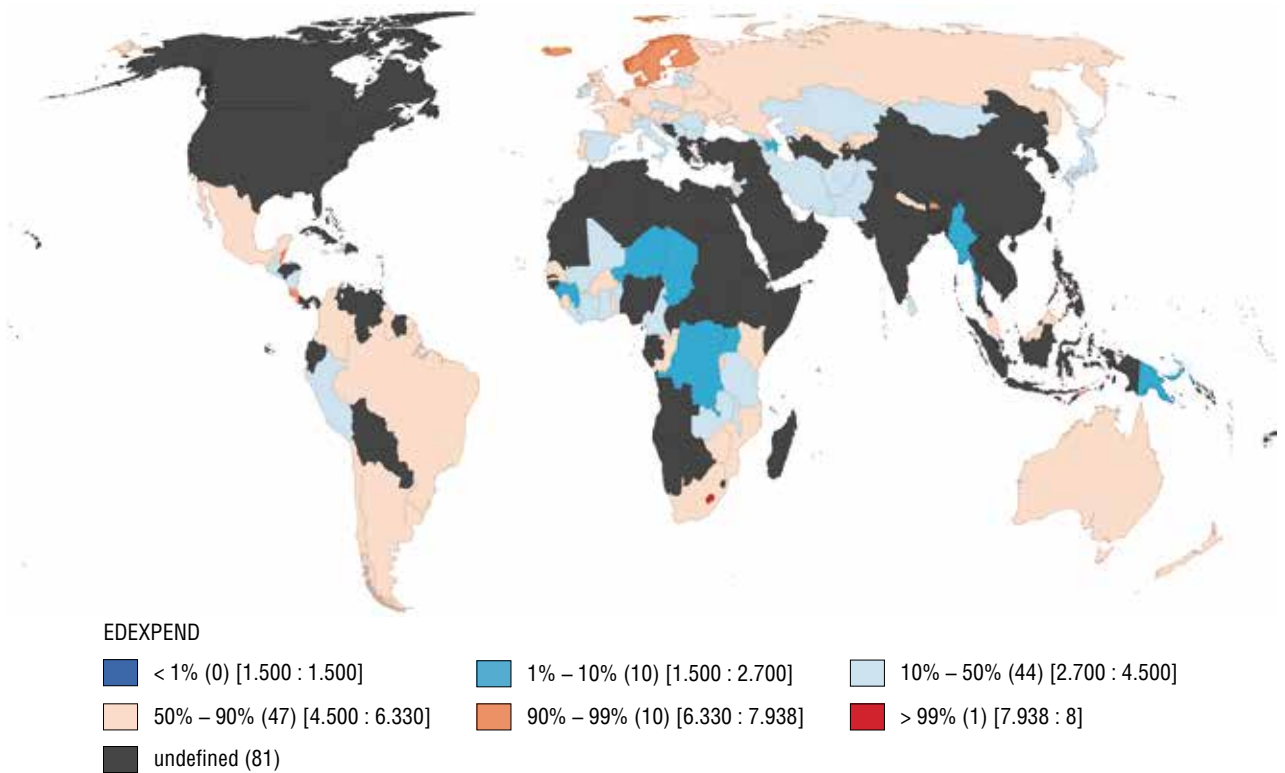


Fig. 7.7.1. Percentile cartogram for the “Education spending” indicator

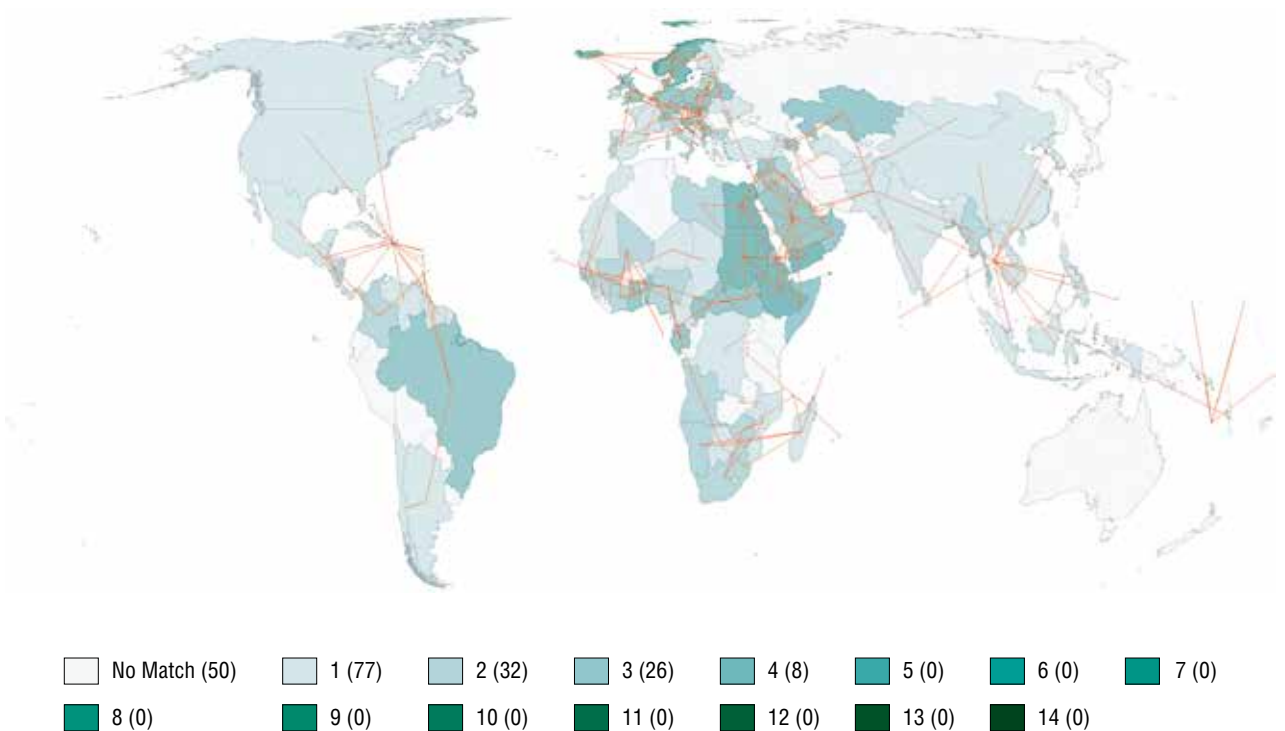


Fig. 7.7.2. Likelihood-ratio test for the “Education spending” parameter

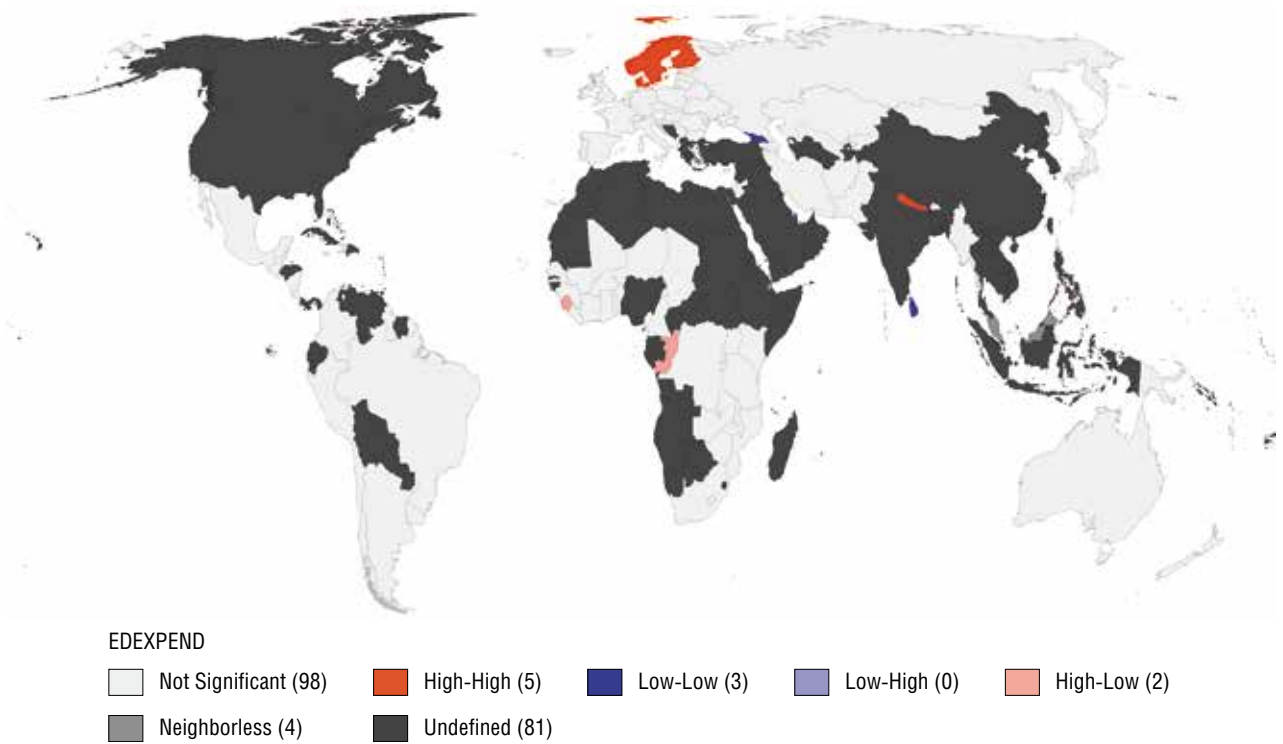


Fig. 7.7.3. “Education spending” spatial autocorrelation cartogram for the geometric neighbourhood matrix

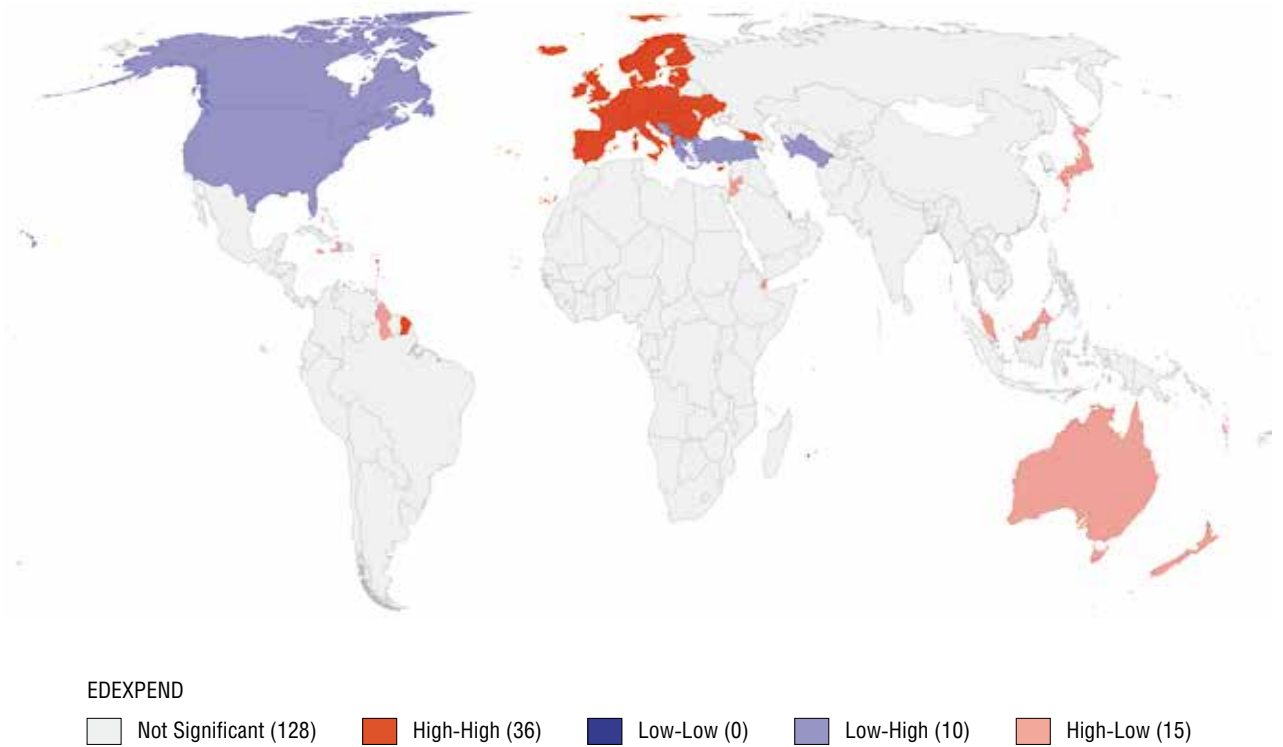


Fig. 7.7.4. “Education spending” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.8. Number of researchers

The number of researchers working in R&D per 1 million population represents the percentage of the population working in R&D, thereby characterizing the development level of research and technology in a given country, and indirectly attesting to the popularity of R&D. “Researchers” means professionals carrying out research and improving or developing concepts, theories, models, engineering methods and software. R&D spans fundamental research, applied research and experimental design.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.588	0.000	0.394	0.000
Geary's C	0.372	0.000	0.603	0.000

High numbers of people engaged in R&D are typical for countries that are highly developed technologically and socioeconomically. The percentile cartogram shows (Fig. 7.8.1) that countries with low indicator values are mostly concentrated in sub-Saharan Africa, Central America, and Central and Southeast Asia. High numbers of researchers are observed in the countries of Europe (primarily the Scandinavian Peninsula), Japan and New Zealand.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix identifies two large clusters (Fig. 7.8.3). The first exhibits low numbers of researchers engaged in R&D and design, and includes countries of Central Africa. Conversely, the second cluster demonstrates high indicator values. It includes the countries of the Scandinavian Peninsula, Western Europe (with the exception of Spain and Portugal), Central Europe and Russia.

The geopolitical neighbourhood matrix cartogram (Fig. 7.8.4) identifies three clusters. A large group of countries with low numbers of researchers working in R&D is concentrated in Africa. Unlike the geometric neighbourhood matrix cartogram, this cluster includes not only states in the centre of the continent, but

Global place	Country	Indicator (per 1 million population)
1	Denmark	7,924.953
2	South Korea	7,497.596
3	Sweden	7,383.419
Mean (39)	(Latvia)	1,731.9952 (1,784.637)
Median (41)	Egypt	677.1002
115	Guatemala	14.0704
116	Rwanda	13.86086
117	Democratic Republic of the Congo	10.56469

also most sub-Saharan countries. The cluster of high indicator values also looks different from the one showed by the geometric neighbourhood matrix and includes most European states, as well as the North American countries of the United States and Canada. Russia, however, does not make this cluster when the geopolitical neighbourhood matrix is used. Characteristically, several countries of the Balkan Peninsula (Bosnia and Herzegovina, Montenegro, North Macedonia) and Eastern Europe (Ukraine, Romania), as well as Turkey form a separate cluster of states since the indicator values for these countries are significantly lower than those of their neighbours.

A comparison of cartograms for the geometric and geopolitical neighbourhood matrices leads to the conclusion that the geopolitical matrix offers a better representation of the structure of the modern world.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Number of researchers” parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The cartogram (Fig. 7.8.2) clearly shows several connection groups: Latin America; Europe, the United State, and Canada; and South and Southeast Asia. Notably, Africa shows two clusters at once: connections identified in the west of Africa, and a Southern African group of countries.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Unused export potential	0.086	0.001	0.337	1.328
2	Inbound tourism	0.122	0.000	0.393	1.269
3	IMF voting power	0.109	0.000	0.360	1.185
4	Cultural solidarity	0.068	0.005	0.281	1.153
5	Export	0.162	0.000	0.431	1.144
6	Import	0.137	0.000	0.391	1.119
7	Services sector	0.046	0.025	0.223	1.083
8	Population growth	0.121	0.000	-0.339	0.953
9	Ethnic minorities	0.114	0.000	-0.326	0.932
10	Number of doctors	0.372	0.000	0.567	0.864

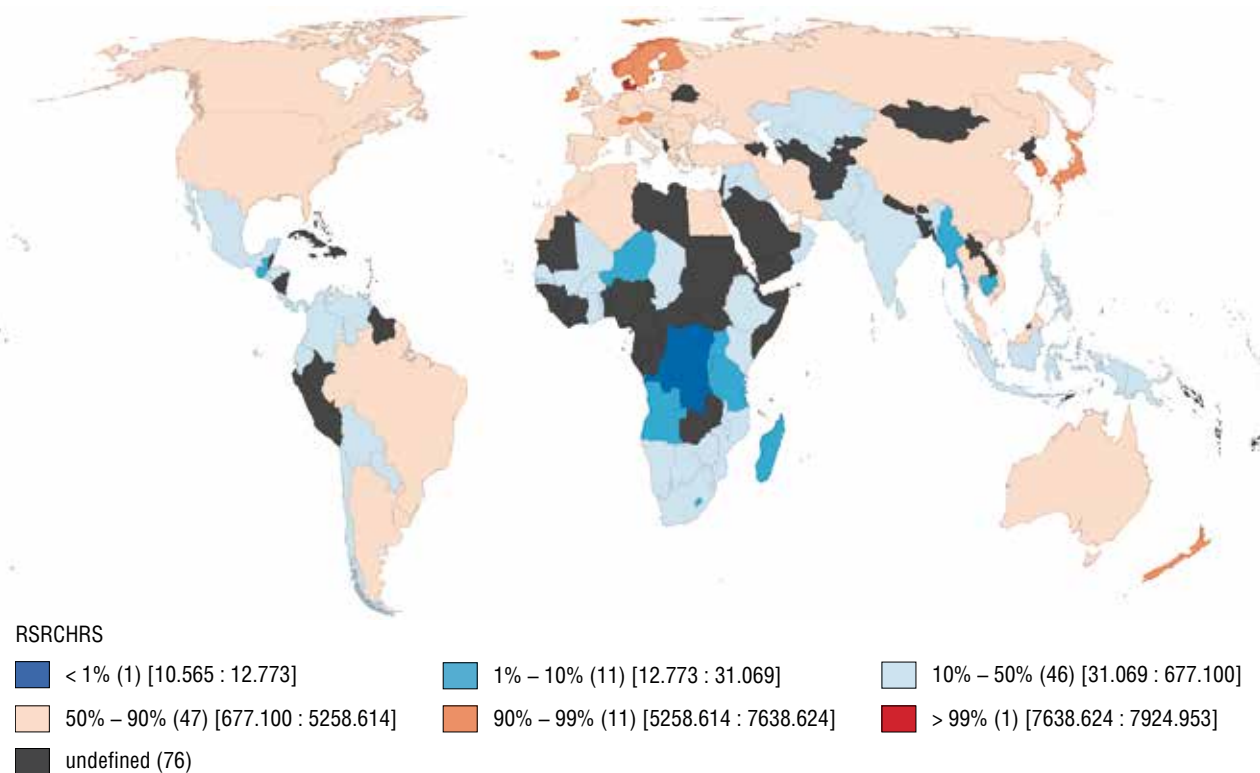


Fig. 7.8.1. Percentile cartogram for the “Number of researchers” indicator

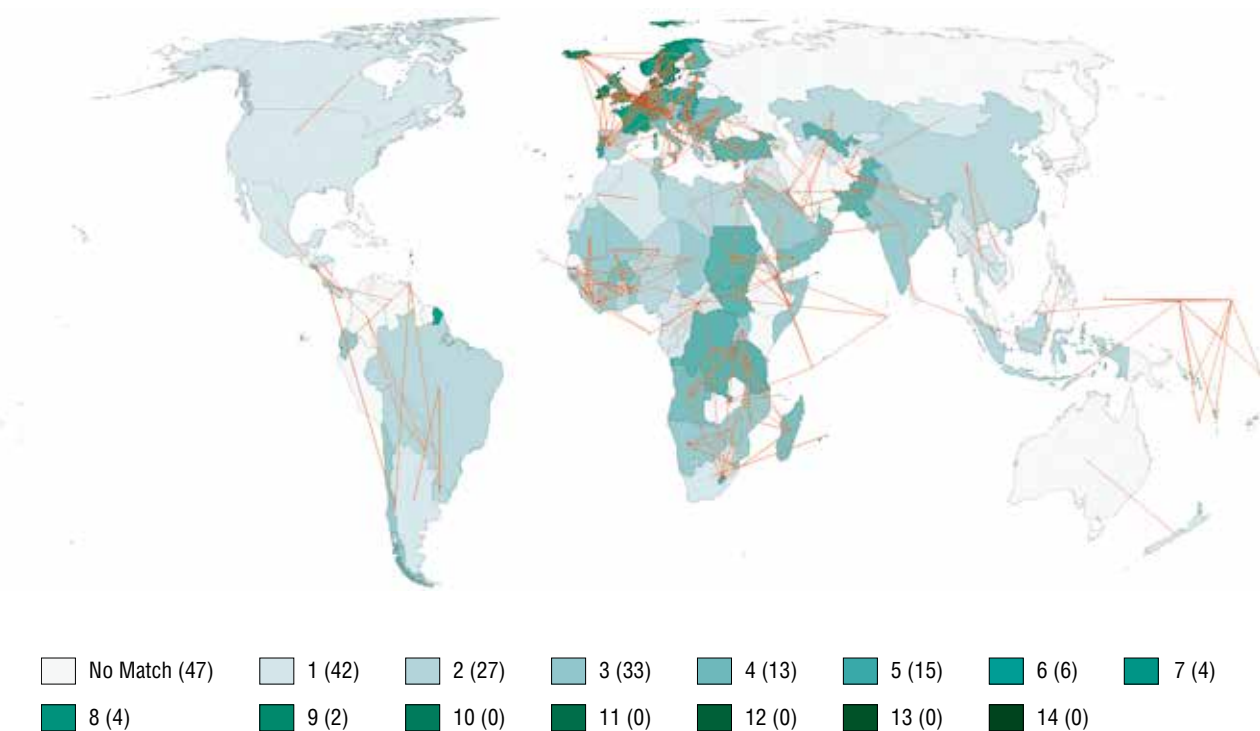


Fig. 7.8.2. Likelihood-ratio test for the “Number of researchers” parameter

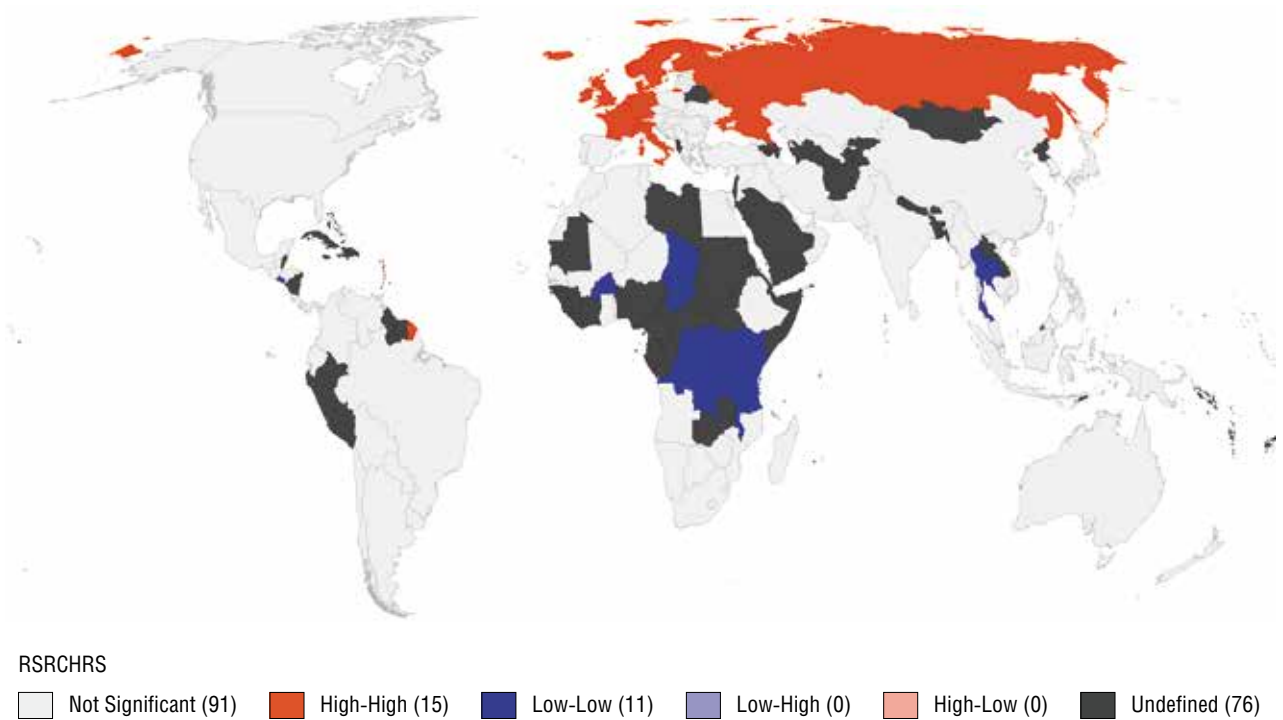


Fig. 7.8.3. “Number of researchers” spatial autocorrelation cartogram for the geometric neighbourhood matrix

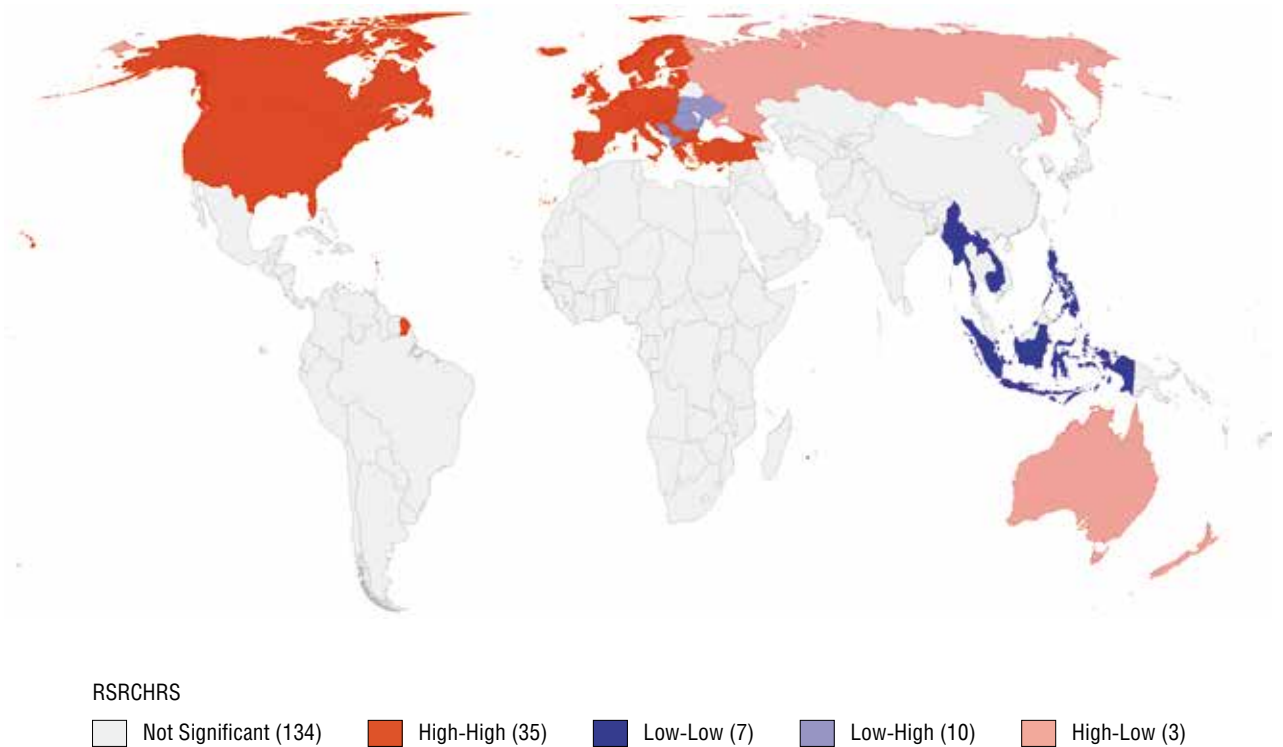


Fig. 7.8.4. “Number of researchers” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.9. R&D spending

The R&D spending indicator expressed as a percentage of GDP is one of the crucial indicators of priority assigned to R&D in a country's domestic development, and it indirectly determines a given state's scientific and technological potential.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.421	0.000	0.295	0.000
Geary's C	0.575	0.000	0.701	0.000

High R&D spending indicator values are typical mostly for states with high economic development levels. As a rule, R&D funding by businesses significantly exceeds governmental funding. The percentile cartogram (Fig. 7.9.1) shows that the highest indicator values are observed in several countries of Europe, East Asia, Israel and the United States. These countries are characterized by a rapid increase in R&D funding, and in the numbers of researchers and scientific publications.

Countries with low indicator values are concentrated in Southeast Asia, Central America, Africa and Central Asia. Low R&D spending is typical for developing states that do not sufficiently focus on matters of developing this area, either because investment in R&D is a low priority, or because these states have difficult socioeconomic circumstances.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 7.9.3) shows two clusters with high R&D spending. The first cluster includes economically developed European countries with high GDP per capita and diversified economies. The second cluster includes Asian states that are traditional regional leaders in R&D spending expressed as GDP percentage: Japan and South Korea.

Since there is no data on R&D spending for many developing countries, the geopolitical neighbourhood matrix cartogram identifies only one spatial cluster, in the Euro-Atlantic (Fig. 7.9.4). Special note should be

Global place	Country	Indicator (GDP %)
1	Israel	4.816
2	South Korea	4.553
3	Sweden	3.397
Mean (43)	(South Africa)	0.8464 (0.832)
Median (65)	Latvia	0.5101
127	Syria	0.205
128	Madagascar	0.0146
129	Mauritania	0,0142

made here of the exceptions of Latvia, Ukraine, Georgia, Cyprus, and five Balkan states (Romania, Bulgaria, Bosnia and Herzegovina, North Macedonia, and Montenegro), whose values are below those of their neighbouring countries.

Unlike the geometric neighbourhood matrix cartogram, the geopolitical matrix cartogram makes it possible to group more European countries and the United States into a single cluster. The United States is among the top ten countries with the highest R&D spending in terms of GDP percentage and is the absolute global leader in R&D investment expressed in relative terms.

No more clusters emerge, since indicator values differ greatly in other geopolitical groups. In particular, the geopolitical matrix cartogram does not identify a cluster of ASEAN+3 member states, including South Korea, Japan and China, which is second in the world in R&D spending expressed in relative terms. There is no cluster here because of the great spread of indicator values in the region's countries.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "R&D spending" parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The relevant cartogram (Fig. 7.9.2) clearly shows two nodes of connections: in Europe and in the countries of the Caribbean. The latter emerged because of similar R&D spending, expanded cooperation between states in science and technology (a regional approach to science, technology and innovations was encouraged in the 2015–2019 Strategic Plan for the Caribbean Community) and ongoing regional integration. Notably, no connection was identified between the United States and any other state.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Ethnic minorities	0.043	0.019	-0.237	1.306
2	Economic inequality	0.123	0.000	-0.362	1.065
3	Highly wealthy population	0.143	0.000	-0.370	0.957
4	Ethnic fractionalization	0.113	0.000	-0.304	0.818
5	Population growth	0.065	0.004	-0.224	0.772
6	Regional trade agreements	0.280	0.000	0.447	0.714
7	Alcohol consumption	0.171	0.000	0.330	0.637
8	Number of doctors	0.208	0.000	0.362	0.630
9	Particulate air pollution	0.137	0.000	-0.283	0.585
10	Conservation areas	0.082	0.001	0.214	0.558

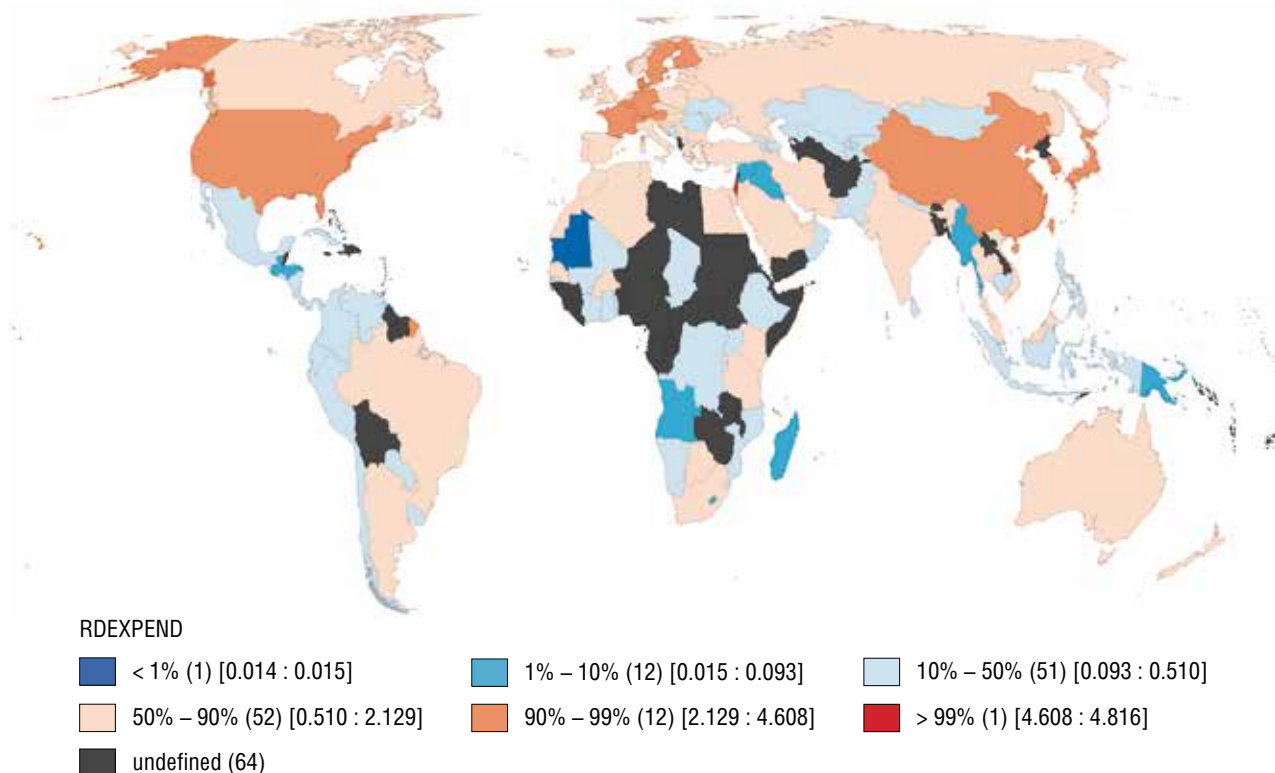


Fig. 7.9.1. Percentile cartogram for the “R&D spending” indicator

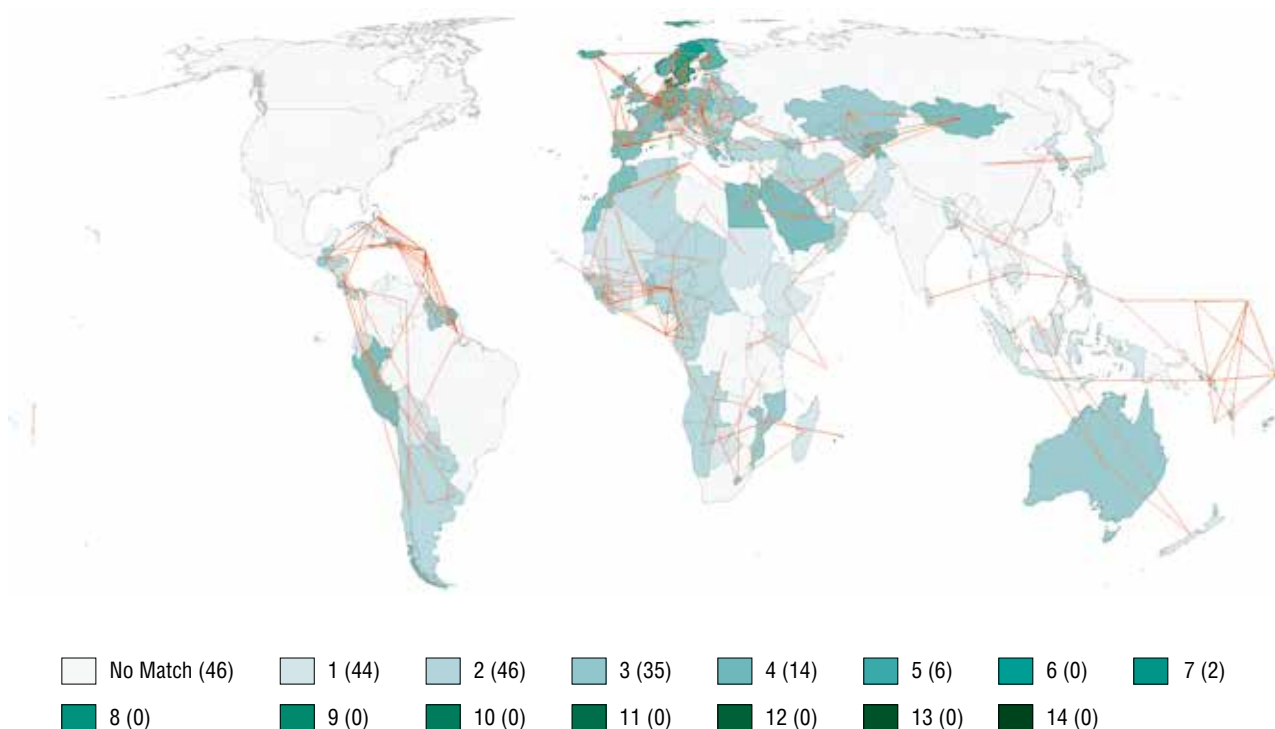


Fig. 7.9.2. Likelihood-ratio test for the “R&D spending” parameter

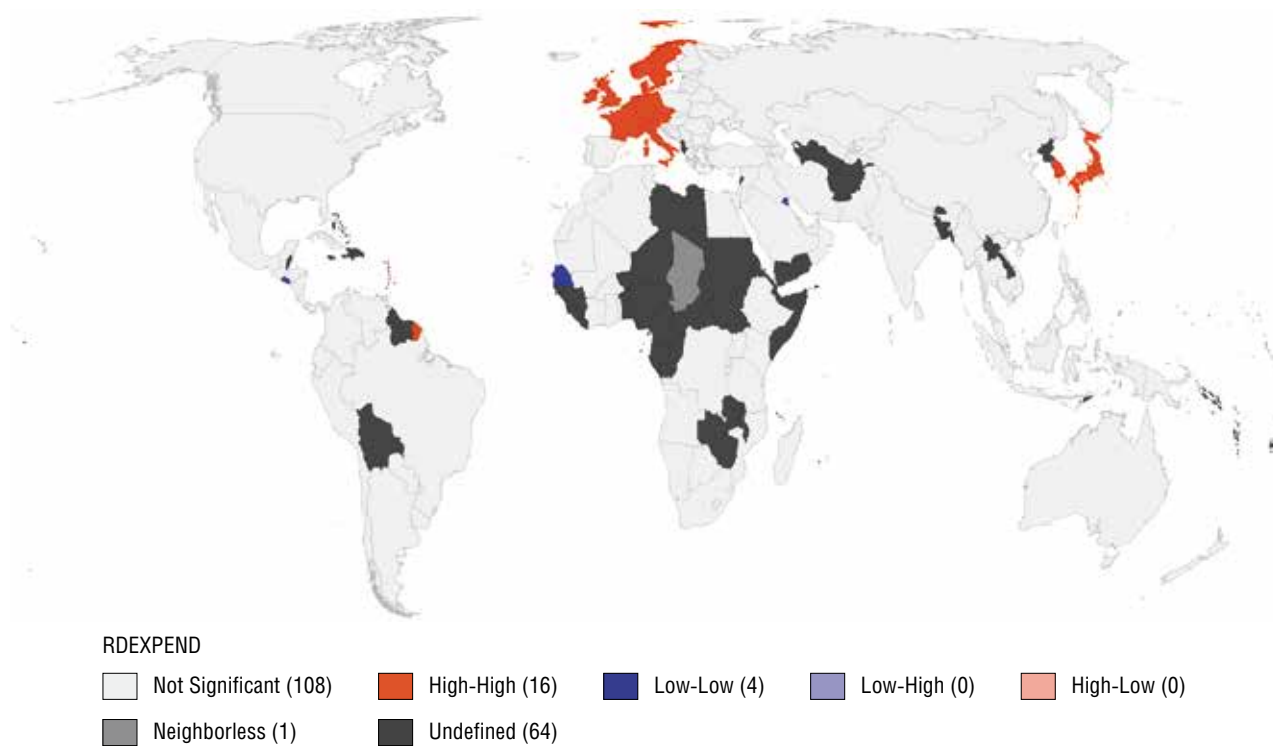


Fig. 7.9.3. “R&D spending” spatial autocorrelation cartogram for the geometric neighbourhood matrix

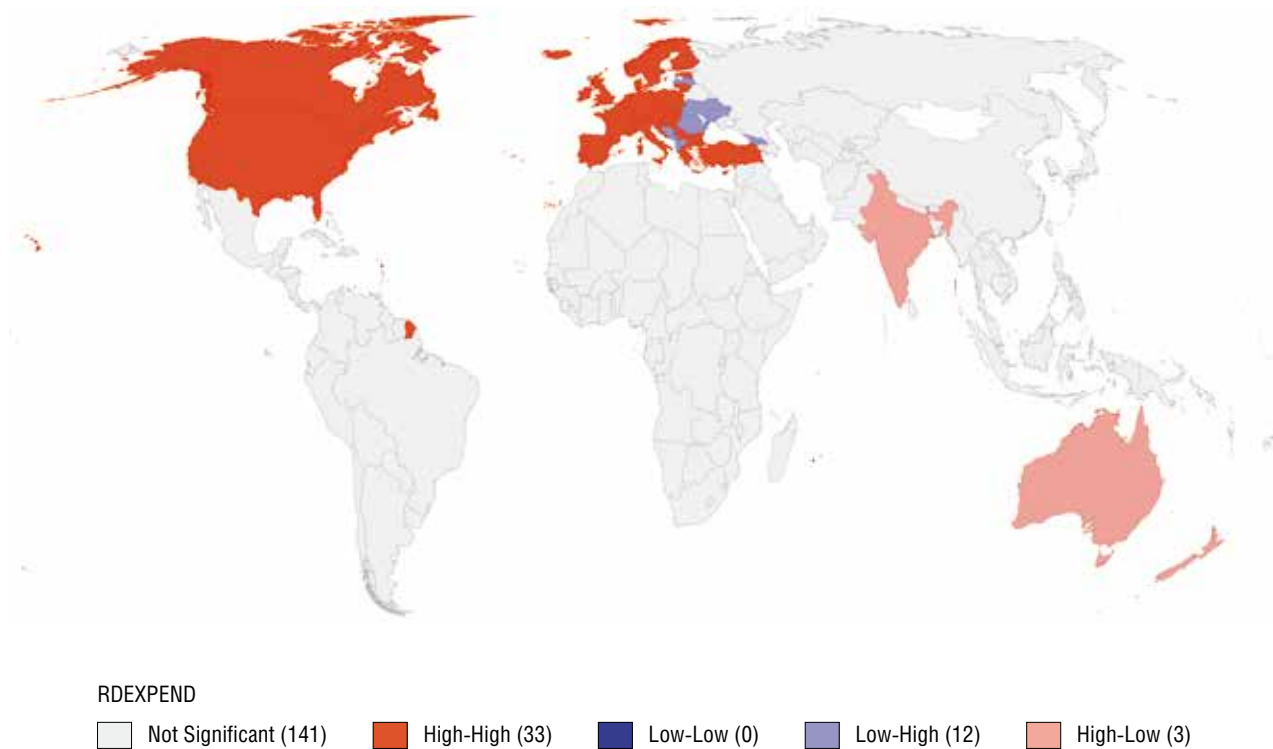


Fig. 7.9.4. “R&D spending” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.10. Publication activity

The number of articles in science and technology journals per 1 million population indicator characterizes the development of science in a country and indirectly attests to the level of research popularity among population. The indicator is calculated for articles published in the following scientific fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, equipment and technology, and Earth and space sciences.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.614	0.000	0.484	0.000
Geary's C	0.352	0.000	0.514	0.000

Higher indicator values are typical for states that combine high levels of socioeconomic prosperity and technological development. The percentile cartogram shows (Fig. 7.10.1) that countries with the highest number of articles published in science and technology journals are concentrated in Central and Western Europe (we should also note high publication activity in Canada, Australia and New Zealand), while low values are typical for countries in Africa and Central Asia.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 7.10.3) shows two large African clusters with low publication activity in science and technology journals. The first is located in the west of the continent and includes Mali with all its southern neighbours. The second cluster with low indicator values is located in Central and East Africa. In both clusters, low numbers of articles in science and technology journals per 1 million population are due to low levels of economic and social development. In the context of the indicator under consideration, we should specifically mention poorly developed education systems, primarily in terms of post-secondary education. The spatial autocorrelation cartogram for the geometric neighbourhood matrix reveals a large cluster of countries with high numbers of articles

Global place	Country	Indicator (units)
1	Switzerland	2,510.9
2	Denmark	2,412.8
3	Norway	2,221.9
Mean (54)	(China)	372.9194 (379.3)
Median (96)	Azerbaijan	76.6
187–188	Chad, Angola	1.0
189	South Sudan	0.8
190–191	Turkmenistan, Somalia	0.6

in science and technology journals located in Western Europe and Scandinavia, which also includes Russia. The cluster's structure is due to the historically formed high technological development of its constituent countries, as well as to intensive governmental research support. The exceptions here are Belarus and Ukraine, where the neighbourhood principle does not work as their indicator values are relatively low, while the values of their neighbours are relatively high.

The geopolitical neighbourhood matrix cartogram (Fig. 7.10.4) shows three large clusters of countries. The first is located in Africa and includes most West African sub-Saharan states, which are characterized by low numbers of articles in science and technology journals per 1 million population. A cluster of countries with high levels of publication activity in science and technology journals includes most European states and, unlike on the geometric neighbourhood matrix, the Balkan Peninsula and Turkey. However, when the geopolitical neighbourhood matrix is used, Russia is not included in this cluster. Another cluster with high numbers of articles in science and technology journals is located in North America and includes the United States and Canada.

A comparison of cartograms for the geometric and geopolitical neighbourhood matrices leads to the conclusion that the geopolitical matrix offers a better representation of the structure of the modern world.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Publication activity" parameter identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The relevant cartogram (Fig. 7.10.2) clearly shows several large clusters: countries of Europe and North America (including countries of the Middle East); Latin American countries; African countries; and countries of Southeast and East Asia, including Oceania. Notably, Russia here is part of the Asian cluster.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Cultural solidarity	0.059	0.002	0.284	1.359
2	Services sector	0.046	0.005	0.239	1.232
3	IMF voting power	0.107	0.000	0.353	1.163
4	Population growth	0.102	0.000	-0.339	1.129
5	Import	0.139	0.000	0.365	0.962
6	Linguistic diversity	0.054	0.001	-0.227	0.954
7	Export	0.163	0.000	0.391	0.940
8	Ethnic minorities	0.072	0.000	-0.254	0.897
9	Hospital beds	0.104	0.001	0.296	0.839
10	Ethnic fractionalization	0.103	0.000	-0.289	0.809

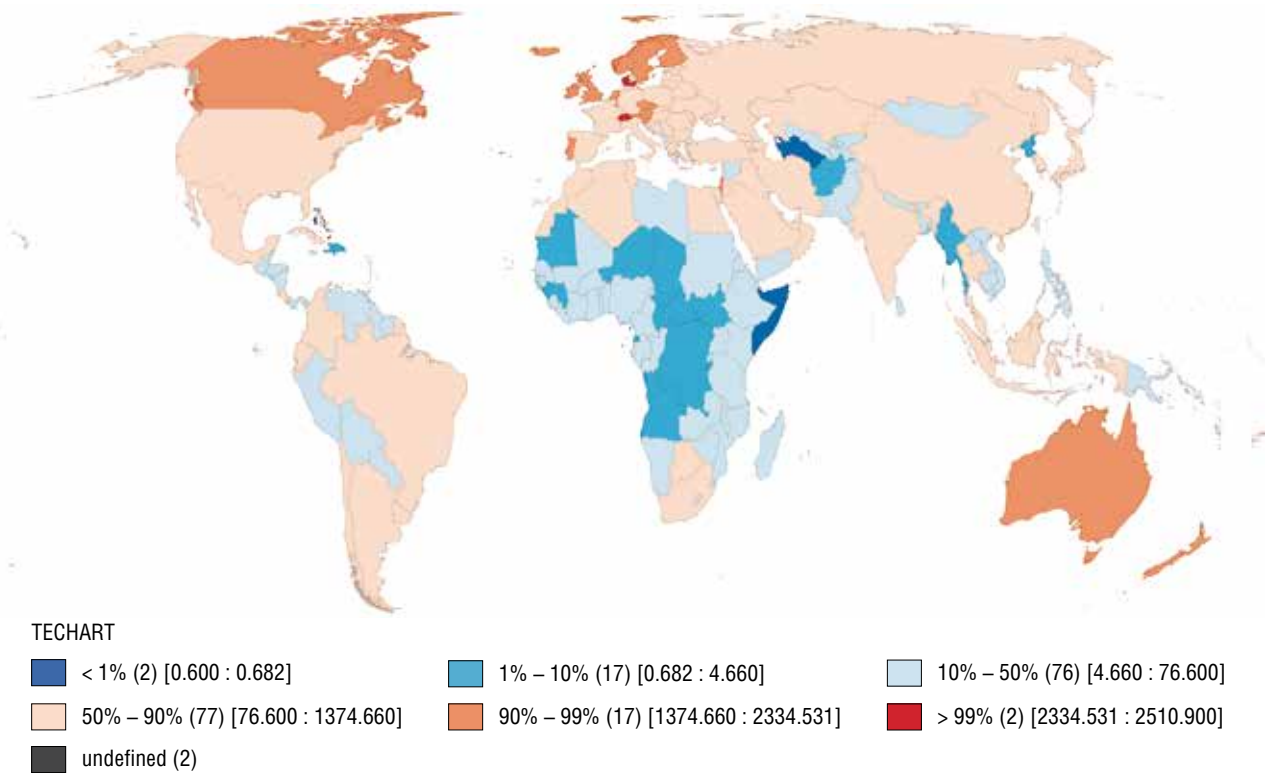


Fig. 7.10.1. Percentile cartogram for the “Publication activity” indicator

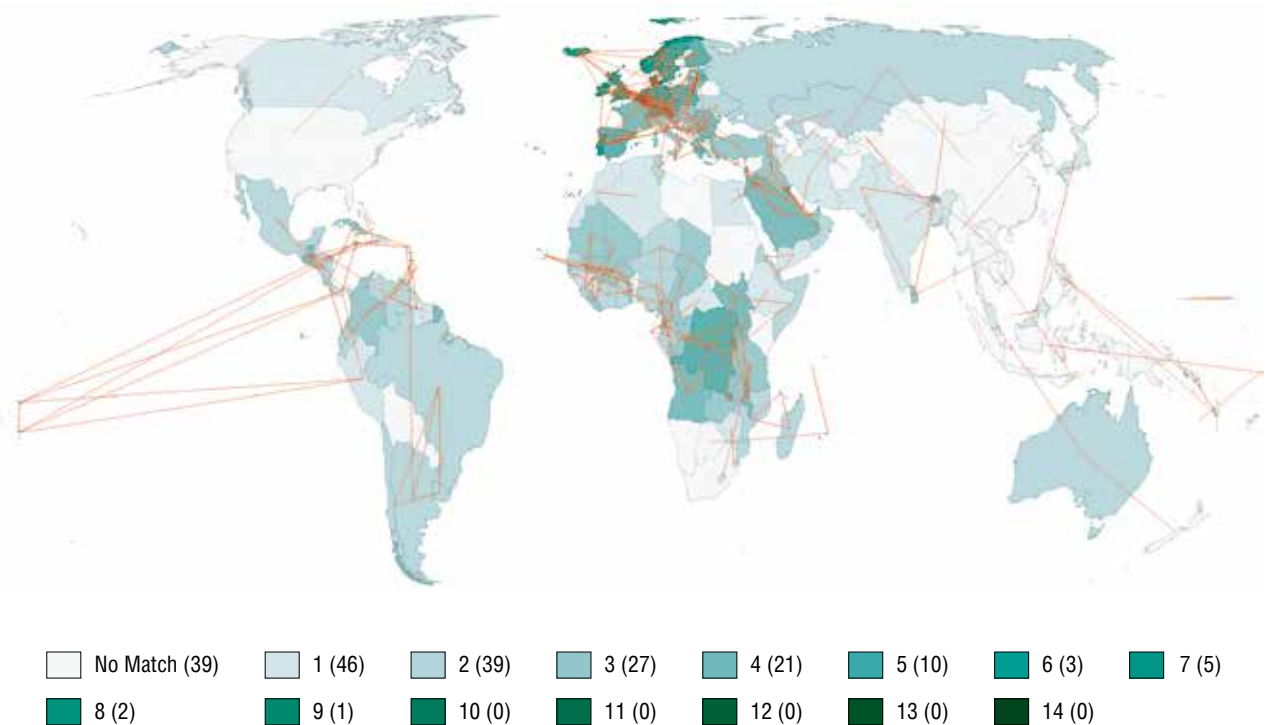


Fig. 7.10.2. Likelihood-ratio test for the “Publication activity” parameter

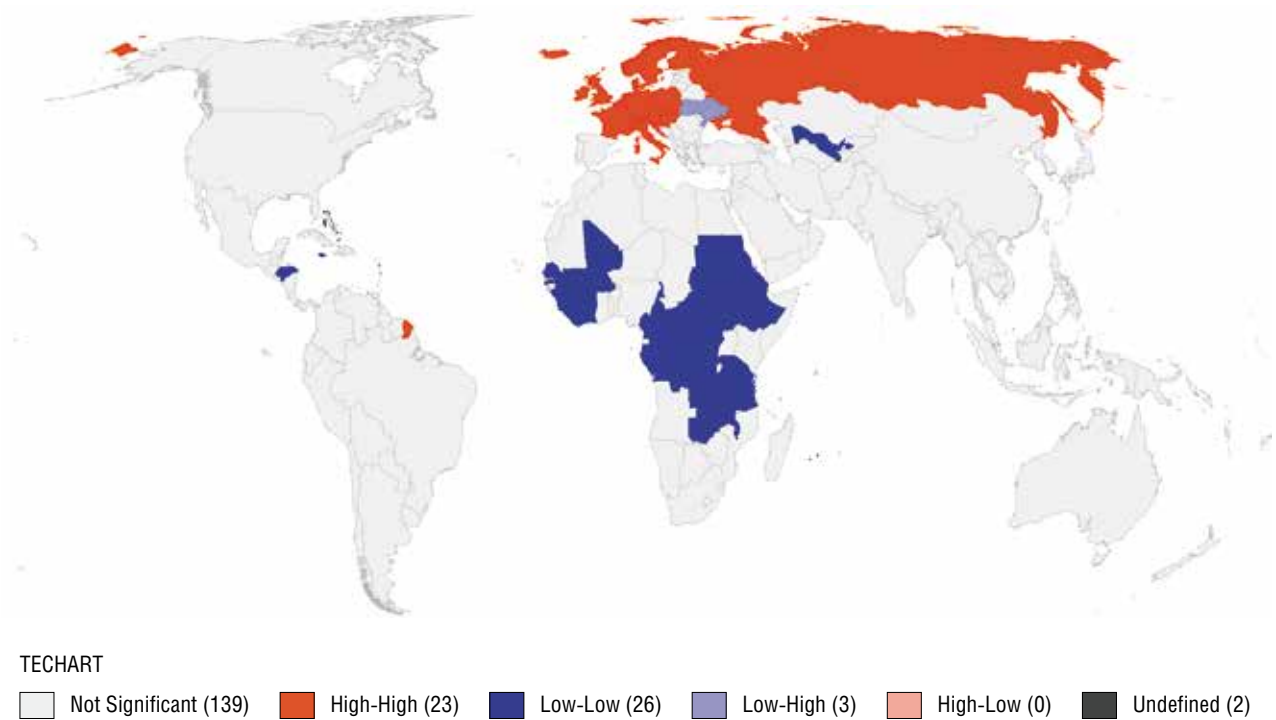


Fig. 7.10.3. "Publication activity" spatial autocorrelation cartogram for the geometric neighbourhood matrix

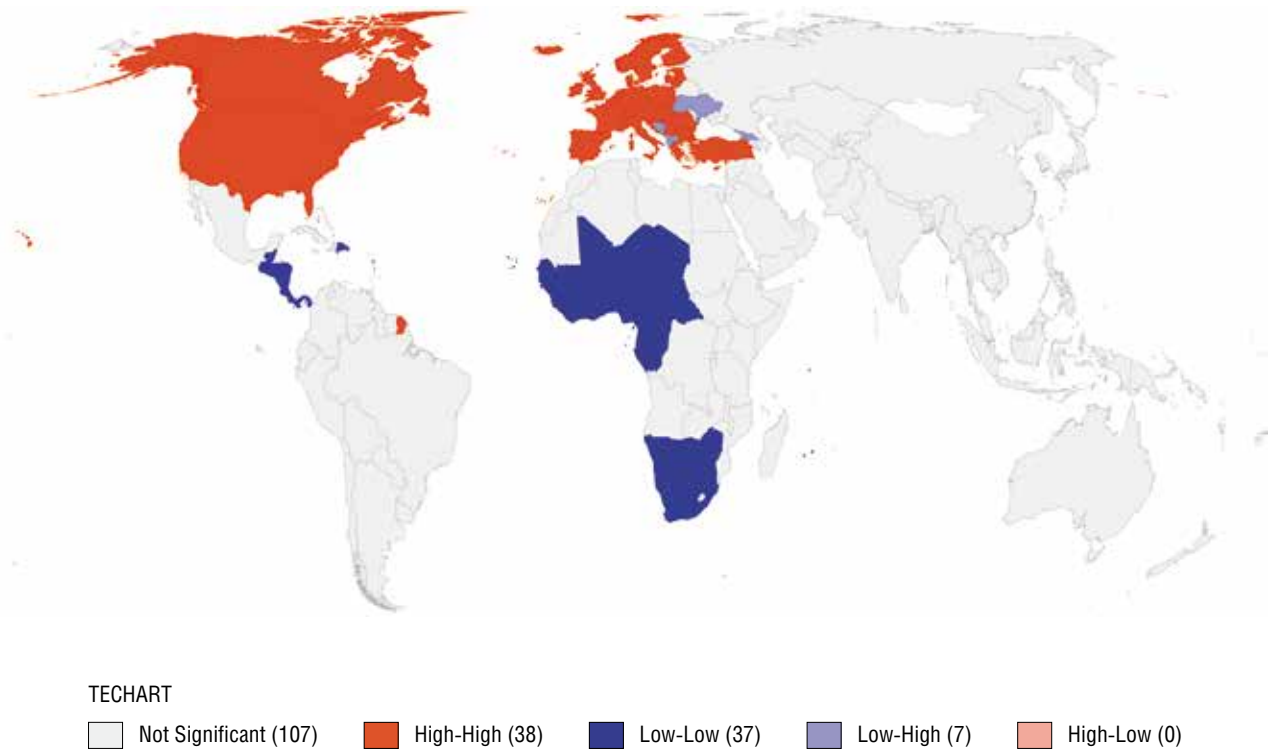


Fig. 7.10.4. "Publication activity" spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

7.11. Multifactor analysis of the “Education and Science” section indicators

Out of the “Education and Science” section indicators, primary education enrolment, tertiary education enrolment, and R&D spending demonstrate significant differences in their geographic averages.

Of the three indicators, the centre of the dark-blue ellipse is the southernmost because the highest values for the dark-blue indicator (Primary education enrolment) are observed in Africa. This is because many older people also receive primary education in Africa. Therefore, in some countries, the enrolment indicator value may be as high as 150%.

The dark-blue ellipse is the most elongated because primary education enrolment in both East Asia and in America is just as high as it is in Europe. The indicator is evenly spread across the map.

R&D spending produces a more compact ellipse, since Europe greatly exceeds Asia and Africa in this respect. Moreover, the “R&D spending” ellipse is turned relative to two other ellipses because it is stretched towards the United States and China–South Korea–Japan. These countries are leaders in R&D spending, while South Asia, Southeast Asia, West Asia, Africa and South America have low research funding.

When geographic average ellipses are considered by geopolitical group, significant differences are observed between the spatial distribution of primary school dropouts and expected years at school adjusted for educational results.

Ellipses exhibit significant geographic differentiation in the Southeast Asia cluster since the highest values of the two target indicators are observed in different countries. Countries in the north (Japan, South Korea) and south (Singapore) of the cluster demonstrate maximum scores in education results and years at school. The highest numbers of primary school dropouts are typical for the countries of Indochina and the island archipelago.

The red ellipse is skewed north-eastward of the dark-blue ellipse in the North African cluster because the percentage of primary school dropouts (the dark-blue ellipse) is higher in the underdeveloped education systems of African states, while maximums in education results and years at school (the red ellipse) are typical for the countries of South and Southwest Asia.

In the Euro-Atlantic cluster, the two ellipses have different shapes: the red one is compact, the dark-blue one is elongated. This is caused by the values for the years at school indicator being similar in the countries of Western and Eastern Europe and in North America. Therefore, this indicator's ellipse is significantly stretched out.

Multifactor Geary's C cartograms identify groups of neighbouring countries with the most similar and most dissimilar values for the ten education indicators compared to their neighbours. Clusters do not emerge because we do not have significant amounts of education data for individual countries (for instance, no clusters were formed under the geometric neighbourhood matrix). To shape clearer groups, we used zeros in cases where no data was available.

With these adjustments, the geometric neighbourhood matrix identifies six clusters of countries similar to their neighbours (Fig. 7.11.1). Four of them are global, that is, they include large number of countries from the relevant region. These are the South American, Central African, European, and South Asian clusters. Notably, the European cluster in this case is expanded eastward and does not include countries of the Pyrenees and the western, Islamic part of the Balkans. The two remaining groups of countries that are similar to their neighbours are relatively small. The Central American cluster includes Belize, El Salvador and Guatemala, while the Middle Eastern cluster includes Saudi Arabia, the United Arab Emirates and Qatar.

The geopolitical neighbourhood matrix (Fig. 7.11.2) changes the picture. There are now eight clusters of countries similar to their neighbours (the Euro-Atlantic, Central American, Latin American, post-Soviet, South Asian clusters), and three Africa clusters (Southern African, Central African, and West African). The heterogeneity of the Euro-Atlantic space is emphasized by the geopolitical matrix identifying a cluster

of countries dissimilar to their neighbours (Bosnia and Herzegovina, Montenegro, Albania, Macedonia). Additionally, compared to the geometric neighbourhood matrix, the cluster in Central America is more pronounced, while the Latin American cluster expands to include Mexico, Chile and Venezuela.

The cluster analysis cartogram non-adjusted for geographic proximity (Fig. 7.11.3) shows only individual groups of neighbouring countries with similar median values of education indicators.

A cluster of Central and Northern European countries emerges in Europe with the United States adjoining it. In some way, education becomes a factor of Euro-Atlantic integration. Countries of Southern Europe (with the exception of Portugal) exhibit median education values similar to those of their Eastern European neighbours: Poland, Slovenia, Hungary, Russia, Ukraine, Belarus, Moldova. Several post-Soviet states and USSR satellites exhibit commonalities of their education sectors: the South Caucasus countries have similar median values to Kazakhstan and Mongolia and Romania.

A cluster of Colombia, Brazil, Peru, Guyana and Uruguay emerged in Latin America. Countries with similar median values for educational sector indicators are concentrated in Africa. The “densest” cluster here is formed in the southeast of the continent.

The second cartogram where the geographic factor is assigned the same value as the sum of all other indicators shows far clearer clusters, but some countries continue to stand out (see Fig. 7.11.4).

Eastern European countries appear more homogeneous in this context. The region’s cohesion is broken only by the Balkan states with high percentages of Muslim population. Moldova and Romania, taking into account the spatial factor, are part of a monolithic cluster consisting of the countries of Southern and Eastern Europe. When the spatial factor is taken into account, a cluster of Central Asian post-Soviet republics emerges, with only Turkmenistan standing out. Latin America now has two clearly shaped clusters: one spans its north and the other its south.

South and Southeast clusters emerge in Asia. In Southeast Asia, there is a cluster of Malaysia, Indonesia and Brunei, joined by the countries of Oceania. China, even taking into account geographical proximity, is more similar to the countries of the Middle East (Egypt, Iran, Saudi Arabia) than to its immediate neighbors.

We should note that the cartogram combining economic statistics and geographic proximity (Fig. 7.11.4) offers a better representation of international regionalization than automatic breakdown of countries by geographic proximity. When taking into account education, one can observe Europe’s split into Western and Eastern, and Asia’s split into South and South-Eastern. The scatter plot representing country values based on multidimensional scaling findings (Fig. 7.11.5) shows profound differences between countries in their aggregate indicators of education and science development. The left-hand part of the chart represents relatively prosperous states, with most of them being OECD members. They have developed education systems, children spend many years in school, dropout percentages are small, women have ensured access to higher education, and science is developing and well-funded.

The right-hand part of the chart represents relatively problematic (or less prosperous) countries. They have less developed education systems, children spend fewer years in school, they have higher dropout percentages, equality in education is lower, and science is underdeveloped.

In the bottom left-hand quadrant, we see the United States and Germany: these two OECD countries from the world’s top ten economies are predictable leaders in educational wellbeing as well.

At the same time, even though Japan has similar economic parameters, it is located at the maximum distance from the principal group of countries.

As China develops economically, it moves towards the OECD countries, but so far, it is located visibly closer than the OECD states to the median indicator values across the entire country sampling.

India is at approximately the same distance from the centre of the chart as China, but directly opposite. While China is approaching the OECD countries, India so far remains closer to those of Asia and Africa.

Benin represents a group of African countries that are outsiders on many education indicators. Finally, the Monaco–Libya pairing represents a group of countries with problematic original statistics. Consequently, they find themselves in an isolated position on the chart.



ENRPRIM, ENRSEC, ENRTERT, LASCHYEARS, SCHYEARS, PRIMDROUT, EDEXPEND, RSRCHRS, RDEXPEND, TECHART
 Not Significant (98) Positive (93) Negative (2)

Fig. 7.11.1. “Education and science” section spatial autocorrelation cartogram for the geometric neighbourhood matrix



ENRPRIM, ENRSEC, ENRTERT, LASCHYEARS, SCHYEARS, PRIMDROUT, EDEXPEND, RSRCHRS, RDEXPEND, TECHART
 Not Significant (70) Positive (110) Negative (13) Undefined (0)

Fig. 7.11.2. “Education and science” section spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

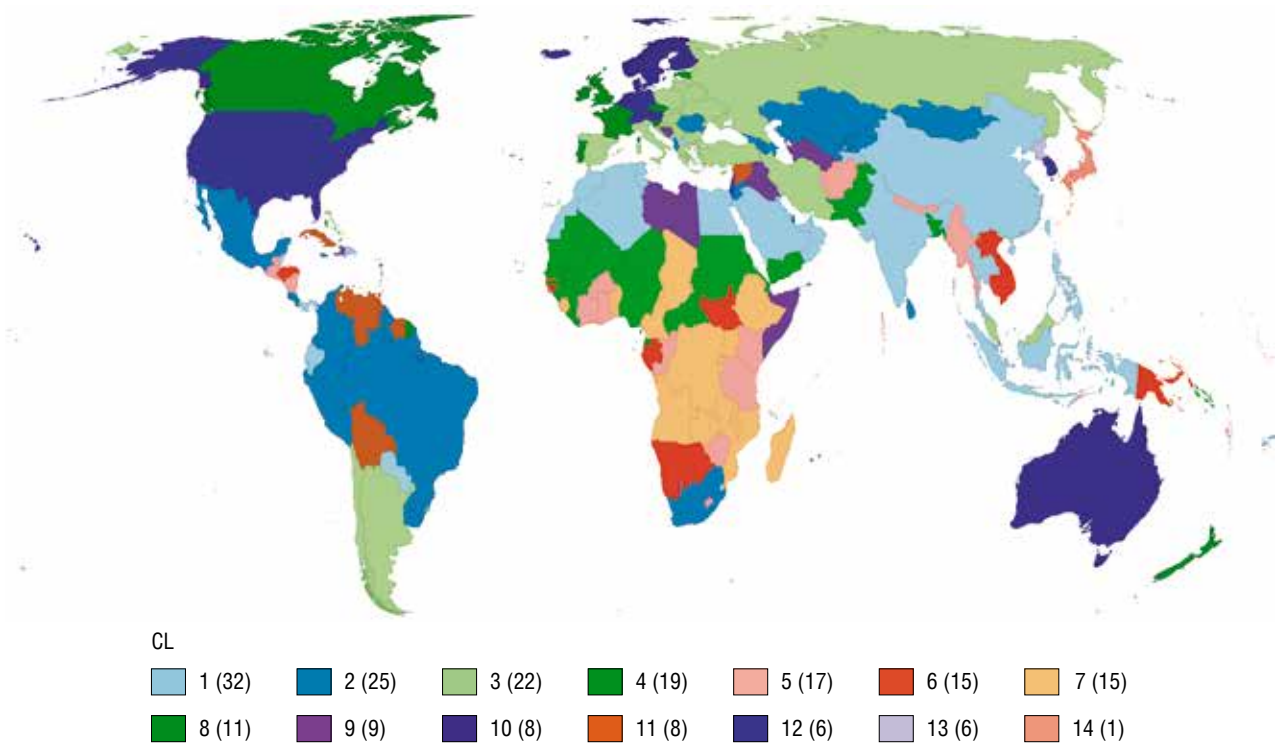


Fig. 7.11.3. Statistical clusters cartogram for the "Education and science" section indicators

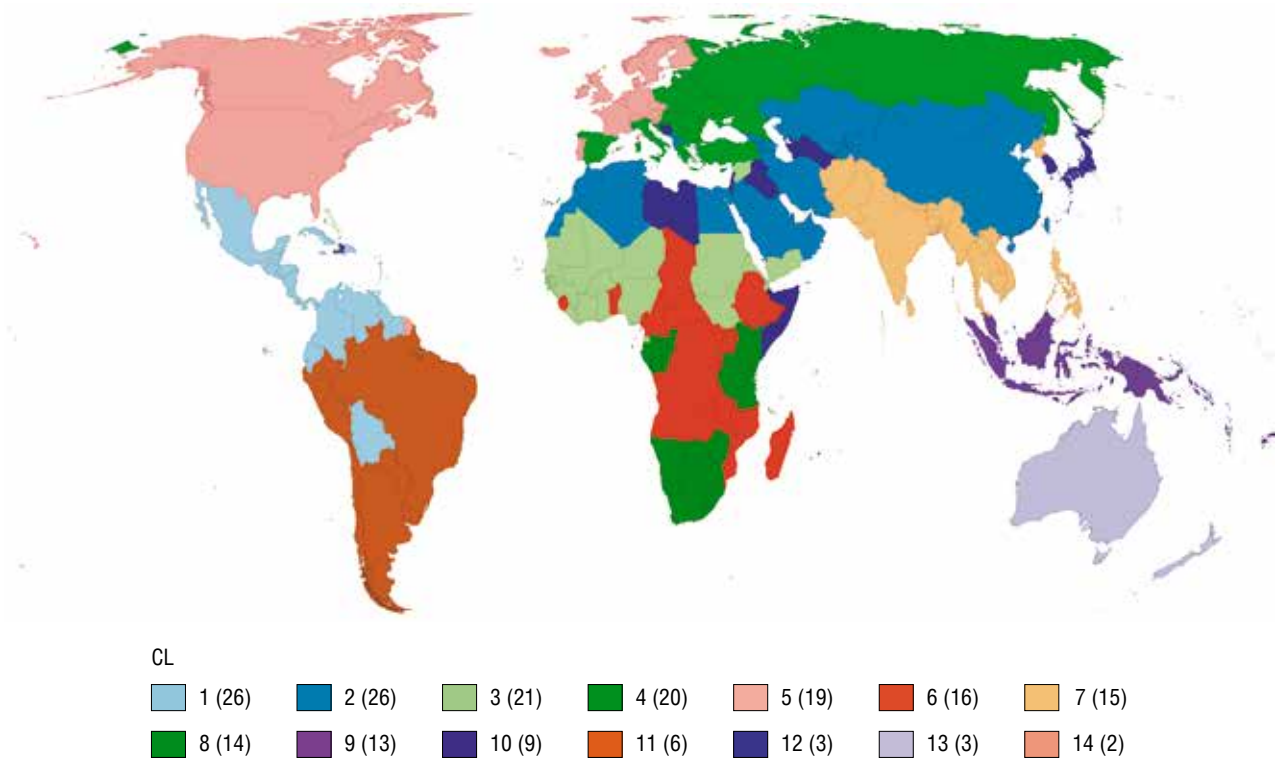
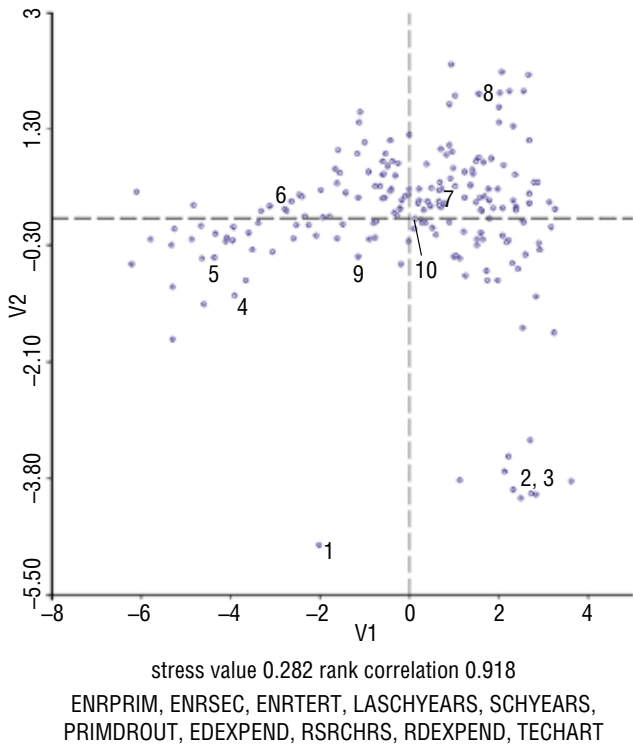


Fig. 7.11.4. Statistical clusters cartogram for the "Education and science" section indicators controlled for geographic proximity



1	Japan
2,3	Libya, Monaco
4	US
5	Germany
6	Russia
7	India
8	Benin
9	China
10	Kuwait

Fig. 7.11.5. Multidimensional scaling chart for the “Education and science” section indicators

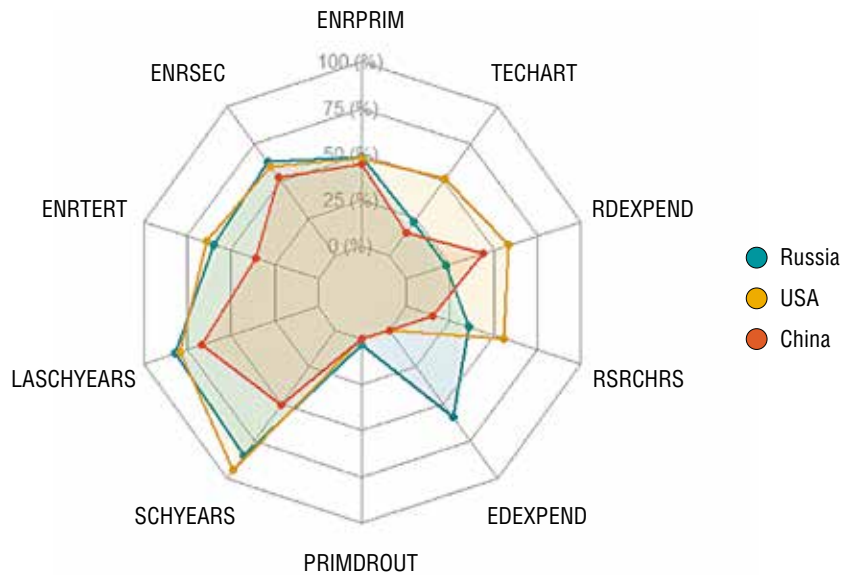


Fig. 7.11.6. Radar chart for the “Education and science” section indicators

7.12. Spatial factor and the “Education and Science” section indicators

The “Education and Science” section was conceived as a two-part section, which is reflected in its title. The idea was that its contents would represent the key parameters in the development of two areas: education (primary, secondary and tertiary) and science. Educational and scientific potential is represented in three aspects: coverage (large scale), quality (productivity) and funding.

For the two-factor analysis, a spatial effect index greater than one was mostly encountered for the following indicators: “IMF voting power” and “Cultural solidarity.” However, all those cases demonstrate a very low coefficient of determination, i.e., a very weak correlation.

For two-factor analysis with maximum spatial effect index, any significant correlation (Pearson’s C greater than 0.3), including spatial autocorrelation (Moran’s I greater than 0.3), is recorded for five indicators:

1. Secondary education enrolment — Regional trade agreements.
2. Tertiary education enrolment — Access to electricity.
3. Tertiary education enrolment — Maternal mortality.
4. Expected years at school adjusted for education results — population growth.
5. Number of researchers engaged in R&D — Number of doctors.

Generally, the hypothesis that the geopolitical neighbourhood has greater significance than geometric neighbourhood for indicators from the “Education and Science” section was not confirmed: Moran’s I for geopolitics was always lower than for geometry, and frequently, the gap was quite significant.

Two out of ten education and science indicators have sufficiently high Moran’s I (greater than 0.5):

- 1) number of researchers engaged in R&D per 1 million population;
- 2) number of articles in science and technology journals per 1 million population.

In both cases, a significant spatial autocorrelation is only recorded for the geometric neighbourhood matrix (0.588 and 0.614, respectively).

The results of multidimensional scaling revealed a statistically expressed division of all countries into those that are relatively prosperous in the field of education and science (mostly OECD countries) and those that are relatively non-improverished (the majority of countries). The countries of the first group boast developed education systems, children spend many years at school, women have ensured access to higher education, and science is developing and well-funded. The second group features less developed education systems, children spend fewer years in school, they have higher dropout percentages, equality in education is lower, and science is underdeveloped.

As China develops economically, it moves towards the OECD countries, but so far, it is located visibly closer than the OECD states to the median indicator values across the entire country sampling. Even though Japan’s economic parameters are similar of those of the OECD states, it is located at the maximum distance from the principal group of prosperous countries in the multidimensional scaling space and lags significantly behind them in many educational indicators.

Africa is a highly specific region as regards education and science development, therefore, an African cluster with some configuration of various African countries frequently emerges pursuant to an analysis of indicators (for instance, see Geary’s C).

Common historical past frequently influences the education systems of the countries of the former USSR, which contributes to the formation of a common Eurasian cluster for many indicators. On the other hand, Eastern European states (Ukraine, Romania) do not become part of the Euro-Atlantic bloc under the geopolitical neighbourhood matrix because their education and science development indicators are closer to those of their eastern neighbours.

We should also note that the culture and history factor determines the isolated nature of education systems in some Balkan states both under the geometric and geopolitical neighbourhood matrices.

GWR of secondary education enrolment (ENRSEC)

Model selection criterion	Indicator	Value	Significance level
Normality of errors	JB p-value > 0,1	—	0,82
Heteroskedasticity	K (BP) p-value < 0,05	—	0,00
Multicollinearity	VIF < 7,5	1,58	—
Spatial Autocorrelation	Moran's I p-value > 0,1	—	0,29
Lagrange Multiplier — Geometry Weights	Lagrange Multiplier (lag)	4,0476	0,04
	Robust LM (lag)	0,0325	0,86
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (lag)	4,0476	0,04
	Robust LM (lag)	0,0325	0,86
Lagrange Multiplier — Geometry Weights	Lagrange Multiplier (error)	7,7972	0,01
	Robust LM (error)	3,7821	0,05
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (error)	7,7972	0,01
	Robust LM (error)	3,7821	0,05

	OLS	SEM Geometry	SEM Geopolitics
Constant	57,066341 (0,000000)	54,851 (0,05846)	31,9766 (0,27480)
YOUNGPOP	-0,721965 (0,000044)	-1,27657 (0,00000)	-1,21128 (0,00000)
GENPARSCHO	22,722227 (0,00000)	52,9149 (0,03376)	72,479 (0,00405)
ENRTERT	0,631206 (0,00000)	0,350478 (0,00000)	0,371561 (0,00000)
LAMBDA	—	0,297501 (0,00161)	0,0858561 (0,60405)
Heteroskedasticity (Breusch-Pagan test)	60,105293 (0,00000)	10,2667 (0,01643)	8,8942 (0,03073)
Normality of errors (Jarque-Bera test)	0,818092 0,664284	—	—
Spatial dependence (Likelihood Ratio test)	—	8,2325 (0,00411)	0,2365 (0,62676)
Akaike info criterion	1783,441663	961,294	969,29
Schwarz criterion		972,308	980,304
R-squared	0,622635	0,751916	0,725751

* P (P-value) significance level is given in brackets.

A regression analysis applied to the “Education and Science” section produced a linear regression model where the secondary education enrolment indicator is the dependent variable, while the percentage of population under 14 (inverse dependence, i.e., a decrease in the share of the population under 14 means we can reasonably expect an increase in secondary education enrolment), gender parity index in school enrolment, and tertiary education enrolment are the explanatory variables. The identified causal relations appears explicable since:

a) The lower the proportion of children percentage in a country, the easier it is to achieve high enrolment numbers in secondary education. Additionally, it is developed countries with a post-industrial economic structure that typically demonstrate a low proportion of young people, and these countries demonstrate nearly 100% secondary education enrolment.

b) The absence of social (including gender) inequality in access to education services increases the overall accessibility of education. If a given social group does not have access to school education, the final coverage indicator may not reach the maximum value.

c) High accessibility and enrolment in general are conditions for developing a higher education system. Therefore, high enrolment figures in tertiary education are typical for countries with a well-developed and high-quality school education systems.

The Lagrange multiplier established the fact that the spatial error method (SEM) is preferable for calculating geographic weighted regression than the spatial lag model (SAR). Comparisons of Akaike information criterion values established that the SEM spatial model is more valid than the non-spatial OLS-model. Additionally, higher R-squared and lower Schwarz information criterion values lead to the conclusion that a model based on geometric neighbourhood weights provides a better explanation for the dependent variable than a model based on the geopolitical neighbourhood matrix.

The regressive model has the highest explanatory value for Central Asian states and several European countries. However, the following cartogram demonstrates that it is unsuitable for explaining the dependent variable for sub-Saharan countries and several countries of West Asia and South America.

Therefore, taken together, spatial measurements performed using various spatial analysis methods lead to the conclusion that space has a visible effect on inter-country differences in the development of education and science. Even though this area is determined by the policies implemented by states within their own borders, the distribution of countries within the space of education and science indicator values is not chaotic, we see traces of spatial autocorrelation. Moreover, correlation under the geometric neighbourhood matrix is consistently stronger than correlation under the geopolitical neighbourhood matrix. We can conclude that physical neighbourhood of states is likely to have greater significance for developing education and science than membership in geopolitical blocs.

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8 *Healthcare*

Healthcare spending

Number of doctors

Pharmaceutical exports

Hepatitis B vaccinations

Antiretroviral therapy (ART)

HIV incidence

COVID-19 mortality

Tuberculosis morbidity

Alcohol consumption

Suicide rate

AN analysis of the indicator set describing healthcare is a key aspect in assessing human development. Given the multicomponent nature of the research subject in this section, the research team decided to notionally divide the totality of processes within healthcare into three categories: healthcare system, population health, and social wellbeing. This approach will produce more adequate assessment criteria for each category. All three categories are central to determining human life expectancy, one of the three components of the human development index.

The healthcare system. Ensuring access to quality healthcare is a crucial objective of the healthcare system, since getting effective targeted medical care may significantly improve many health indicators and prevent premature deaths. Even though the healthcare system of every country is unique due to historical and socioeconomic differences between states, all healthcare systems have such functions as providing patients with accessible and effective medical services at optimal cost.

To assess the effectiveness of a healthcare system and conduct an inter-country comparison, the research team selected five indicators: per capita healthcare spending; number of doctors per 10,000 population; pharmaceutical exports; percentage of children under the age of one vaccinated against hepatitis B; and antiretroviral therapy coverage. These indicators were selected because they provide information on those processes that are subjected to a greater degree of control from the healthcare system, and from the state in general.

Population health. When assessing healthcare, it is important to take into account the widely held opinion among medical experts 50–70% of human health (and, consequently, life expectancy) depends on way of life and environmental conditions. A healthy lifestyle is known to fully depend on the behavioural model chosen freely and independently by the individuals, which may include healthy eating habits, quitting harmful habits, physical activity, etc.

Consequently, the research team selected three indicators that do not directly depend on the accessibility and effectiveness of the healthcare system: number of HIV infections, coronavirus mortality per 1,000 cases, and tuberculosis morbidity per 100,000 population.

Social wellbeing. Socioeconomic factors directly affect quality of life and people's satisfaction with their living conditions, which, in turn, affects a person's physical and mental wellbeing. Such variables as low per capita income and the feeling of insecurity due to the unstable economic and political situation frequently induce people to take up harmful habits and sometimes prompt them to engage in self-destructive behaviour, including suicide.

The research team believes that two indicators should be assessed when considering social wellbeing: per capita alcohol consumption (aged 15 and older) and suicide rate per 100,000 population.

8.1. Healthcare spending

The “Per capita healthcare spending” indicator makes it possible to run an inter-country comparison of resources spent on providing healthcare. Additionally, SDG 3 Ensure healthy lives and promote well-being for all at all ages includes Target 3.c: “Substantially increase health financing [...] in developing countries...” (UN Sustainable Development Goals).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.551	0.000	0.329	0.000
Geary's C	0.427	0.000	0.667	0.000

The percentile cartogram (Fig. 8.1.1) shows that high healthcare spending is typical for developed states with a relatively high GDP per capita, while low figures can be observed in states with less developed economies. Additionally, lower indicator values may be due to large population numbers in those countries whose economic potentials are similar to those in less populated states (less populated countries demonstrate better healthcare financing results). The United States, with its private health insurance system, is the leader here, while the Democratic Republic of the Congo, an extremely poor African state, brings up the rear.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.1.3) identifies three clusters: one cluster with high per capita spending and two clusters with low per capita spending. The high-value cluster is located on the European continent and includes states with relatively developed economies, and in some cases with relatively small populations. The first cluster of low values predictably emerged in the countries of West, Central and East Africa, which do not have the resources to provide medical care. However, the second cluster of low values that includes Russia and countries of South and East Asia indirectly indicates that healthcare spending does not always directly confirm the sector's

Global place	Country	Indicator (USD)
1	Democratic Republic of the Congo	18.51
2	Madagascar	22.05
3	Gambia	22.16
Median (94)	Peru	369.1
Mean (142)	(Panama)	1,138.83 (1132)
185	Norway	8,239
186	Switzerland	9,871
187	US	10,624

effectiveness: the place of Russia's relatively developed medicine in this cluster is rather explained by the major difference in exchange rate between the US dollar and the Russian rouble.

The data obtained for the geopolitical neighbourhood matrix cartogram (Fig. 8.1.4) shows a greater compliance with the indicator value distribution on the percentile cartogram. Four spatial clusters are observed. A high-value cluster is formed by countries that are members of both NATO and the European Union. Accordingly, the geopolitical neighbourhood matrix now shows the United States leading in healthcare spending. Within the African low-value cluster there was a fragmentation into several smaller clusters in the southern, western and eastern parts of the continent. We should also note that the Asian low-value cluster has shrunk since the relatively developed medical systems in Russia and China do not fit into its patterns. As an additional advantage, the geopolitical neighbourhood matrix now shows a new type of low value spatial cluster in the region of the countries of the Black Sea and Eastern Europe, which neighbours clusters with high values. This appearance of the cluster is quite logical since these countries are less economically developed compared to their neighbours.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the "Healthcare spending" parameter (Fig. 8.1.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The densest network of high value correlations is located in the countries of Central and Northern Europe, and, conversely, a dense network of low values is concentrated in the countries of West, Central and East Africa. The Likelihood-ratio test yielded "new" data of sorts in the form of a network of similar values in South America that could potentially form another spatial cluster.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Population growth	0.054	0.001	-0.253	1.185
2	Linguistic diversity	0.047	0.003	-0.231	1.135
3	Motorways	0.041	0.006	0.207	1.045
4	Gender parity at school	0.035	0.034	0.178	0.905
5	Economic inequality	0.093	0.000	-0.287	0.886
6	Ethnic minorities	0.062	0.001	-0.234	0.883
7	Number of doctors	0.311	0.000	0.523	0.88
8	Women in politics	0.085	0.000	0.268	0.845
9	Regional trade agreements	0.336	0.000	0.53	0.836
10	Cultural solidarity	0.07	0.001	0.241	0.83

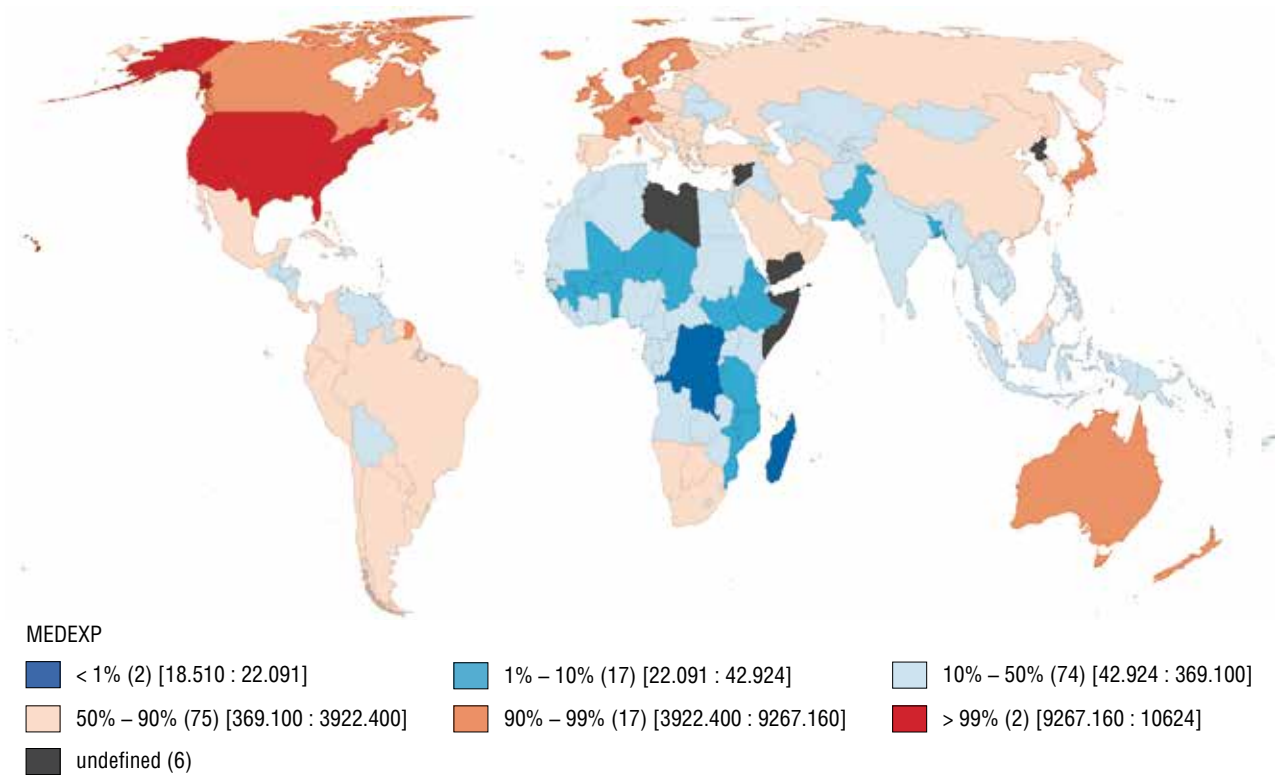


Fig. 8.1.1. Percentile cartogram for the “Healthcare spending” indicator

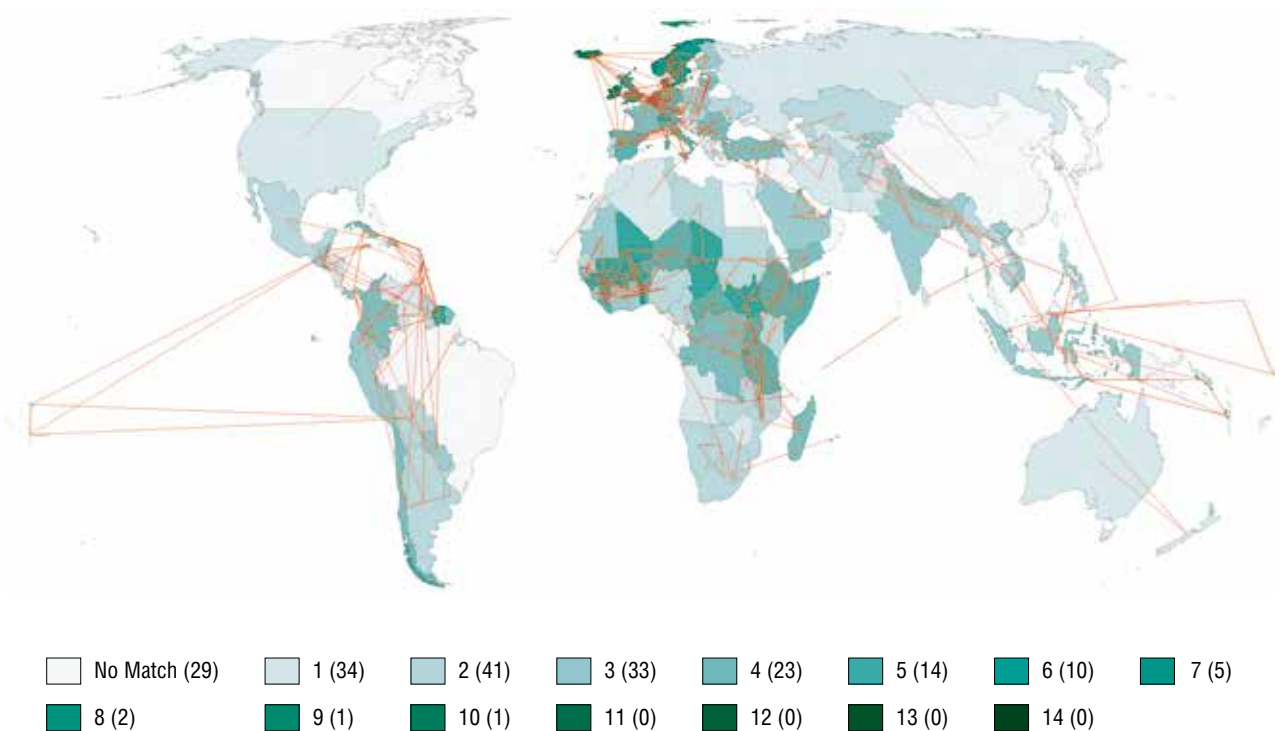


Fig. 8.1.2. Likelihood-ratio test for the “Healthcare spending” parameter

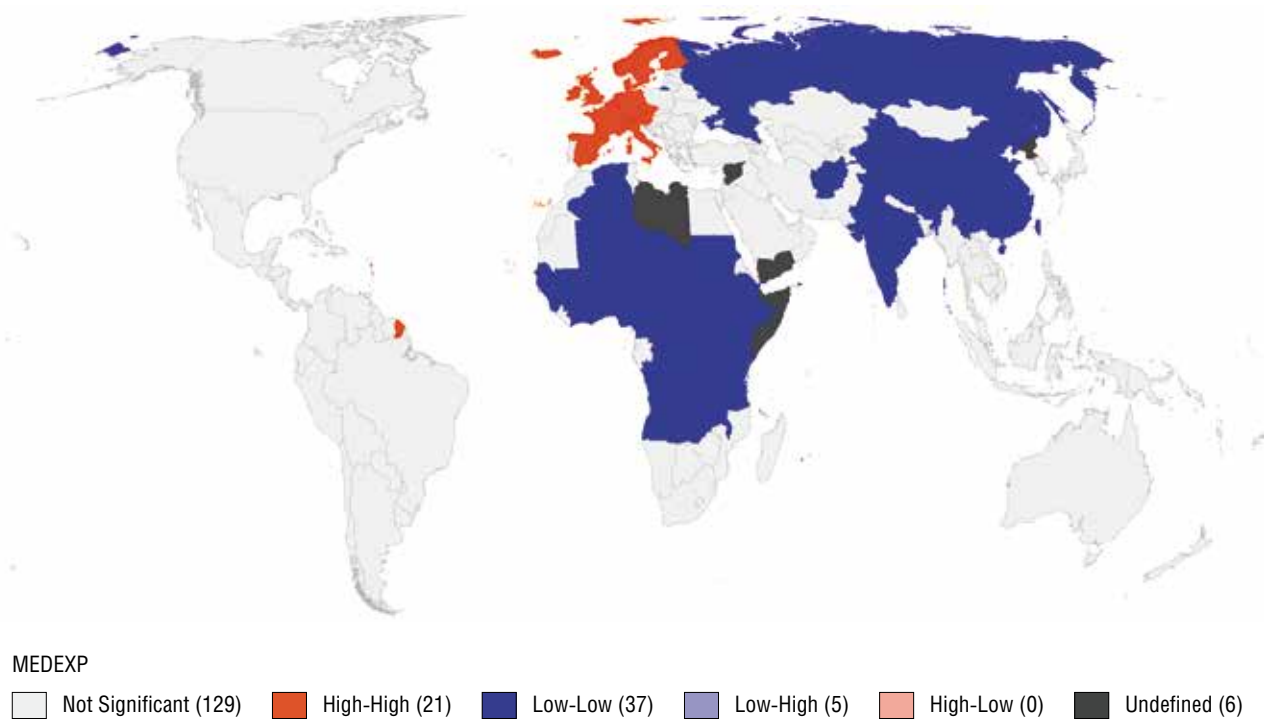


Fig. 8.1.3. “Healthcare spending” spatial autocorrelation cartogram for the geometric neighbourhood matrix

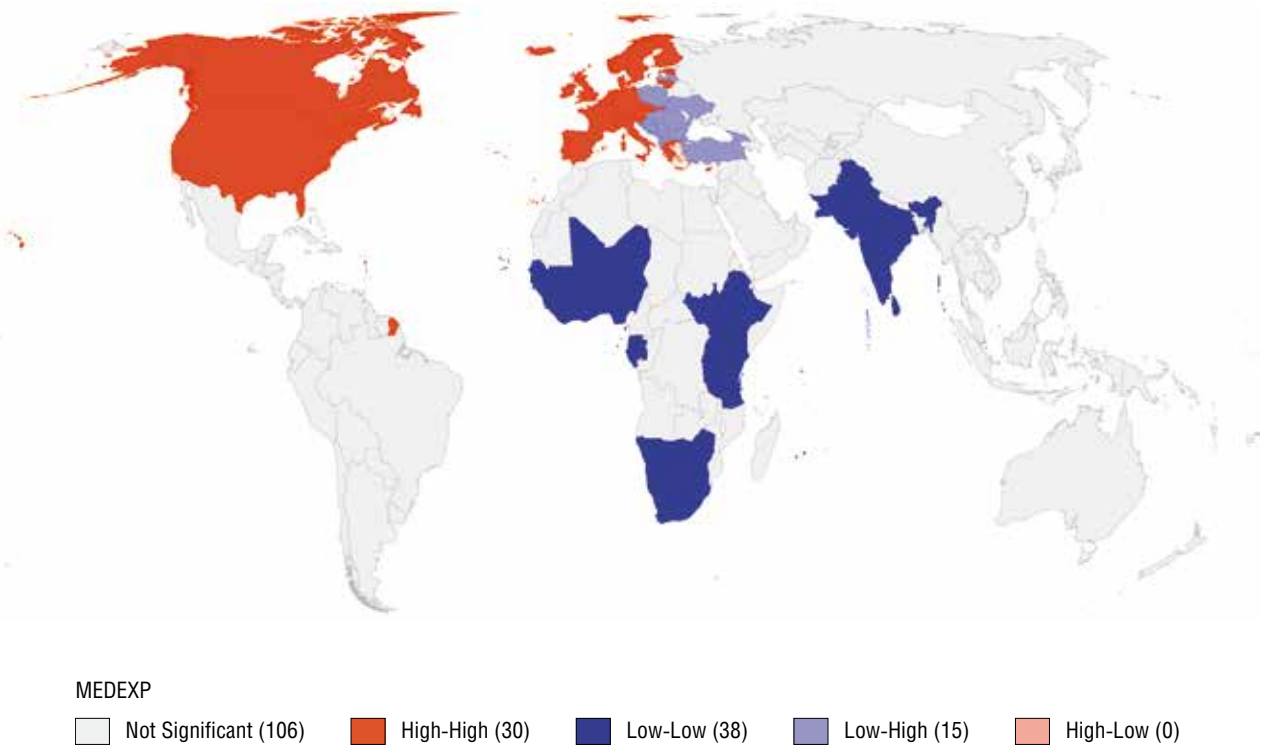


Fig. 8.1.4. “Healthcare spending” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.2. Number of doctors

Values for the “Number of doctors per 10,000 population” achieved by all countries are among the key indicators of implementing SDG 3 Ensure healthy lives and promote well-being for all at all ages.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.533	0.000	0.512	0.000
Geary's C	0.458	0.000	0.485	0.000

The percentile cartogram (Fig. 8.2.1) shows that low indicator values are typical for countries that have both large populations and low GDP. Accordingly, relatively high indicator values are observed in countries that have smaller populations and/or low population density while also having stronger economies with sufficient resources to fund and train medical personnel.

The leader here is Cuba, which is likely due to its active governmental policy of ensuring equal rights to healthcare access enshrined in its Constitution. Last place is Somalia, an essentially collapsed state. The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.2.3) shows two clusters: one cluster includes countries with high numbers of doctors per 10,000 population and the other cluster includes countries with low numbers of doctors per 10,000 population. The first and largest cluster is primarily situated on the European continent, although Russia and the United States align with it. It is the locus of countries with relatively developed economies that create conditions for training medical personnel and providing the population with medical specialists. The cluster of low values is located in sub-Saharan Africa and spans the world's poorest countries, which frequently lack sufficient resources to ensure a basic level of security for their people. Turkey is an interesting case, as it forms a mini-cluster on its own, thus serving as a “watershed” of sorts between countries with relatively low numbers of doctors and states with more developed healthcare systems.

Global place	Country	Indicator (people)
1	Somalia	0.23
2	Malawi	0.36
3	Liberia	0.38
Median (95)	Brunei	16.09
Mean (108)	(China)	19.99 (19.8)
187	Monaco	75.07
188	Italy	80.13
189	Cuba	84.2

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 8.2.4) features spatial clusters that better correspond to the percentile cartogram. A large cluster with high values of the indicator under consideration includes NATO member states that have developed economies and generally highly developed healthcare sectors. Turkey, a NATO member state, again stands out in the geopolitical matrix as a country with relatively low indicator values compared to its neighbours, which is probably due to its relatively low GDP.

The sub-Saharan cluster of low values is essentially duplicated, but a new group of clusters stands out in South America. One of these includes Peru, Bolivia and Paraguay, all of which have relatively low numbers of doctors. Conversely, countries in the east of the continent form a high-value cluster for this indicator, which is again explained by different economic development levels.

We can also identify a mini-cluster of “errors”: Australia and New Zealand, which form the core of their geopolitical cluster, are far ahead of Oceania states in terms of the number of medical personnel because of their colonial past and, consequently, greater economic potential for healthcare development. Therefore, they belong to the category of countries with high numbers of doctors per 10,000 population, although the neighbourhood logic would appear to suggest that they should have low values like their neighbours.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Number of doctors” parameter (Fig. 8.2.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The test predictably demonstrates the densest networks of correlations in Europe and Africa, which form favourable and unfavourable spaces of sorts for the training of medical personnel.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Royalties to foreign copyright holders	0.039	0.015	0.186	0.887
2	Tuberculosis morbidity	0.227	0.000	-0.426	0.799
3	Access to electricity	0.299	0.000	0.488	0.796
4	Unused export potential	0.038	0.007	0.173	0.788
5	IMF voting power	0.063	0.001	0.222	0.782
6	Linguistic diversity	0.169	0.000	-0.359	0.763
7	FDI income	0.067	0.001	0.225	0.756
8	Depletion of natural resources	0.056	0.002	-0.204	0.743
9	Regional trade agreements	0.374	0.000	0.519	0.72
10	Population growth	0.289	0.000	-0.452	0.707

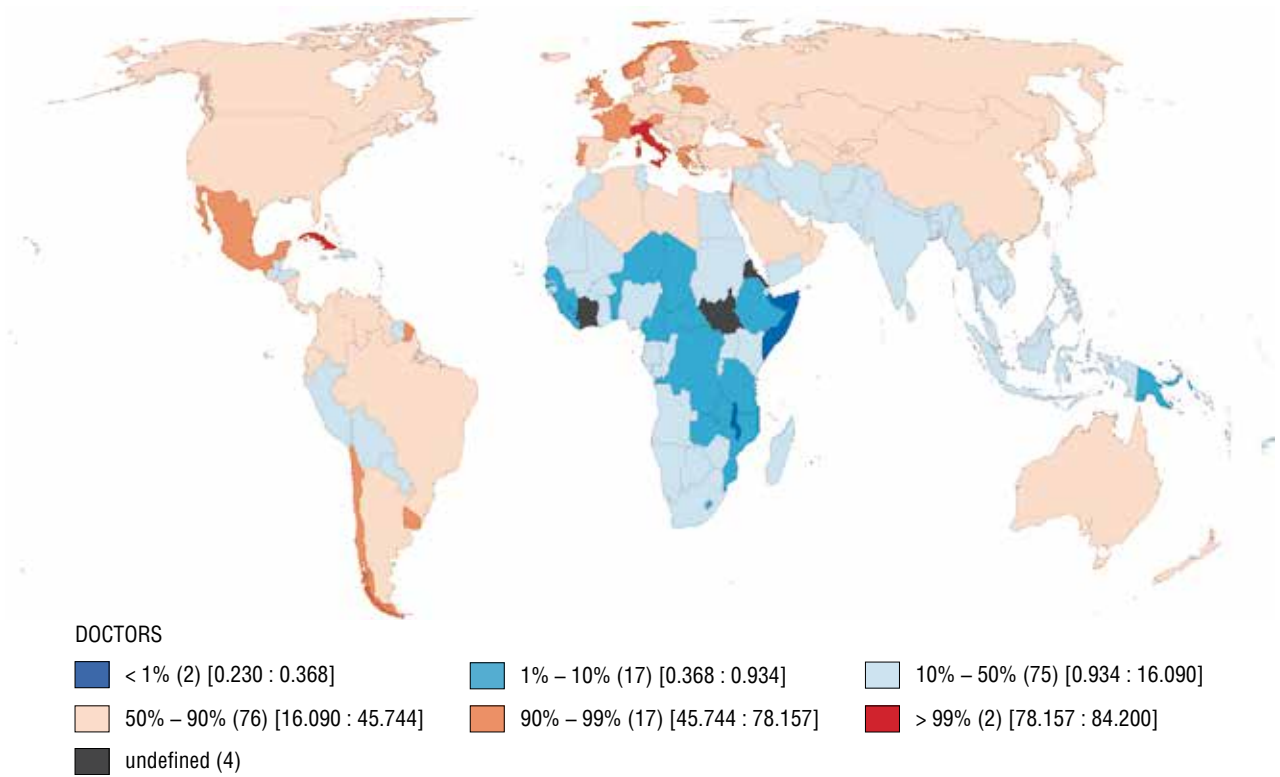


Fig. 8.2.1. Percentile cartogram for the “Number of doctors” indicator

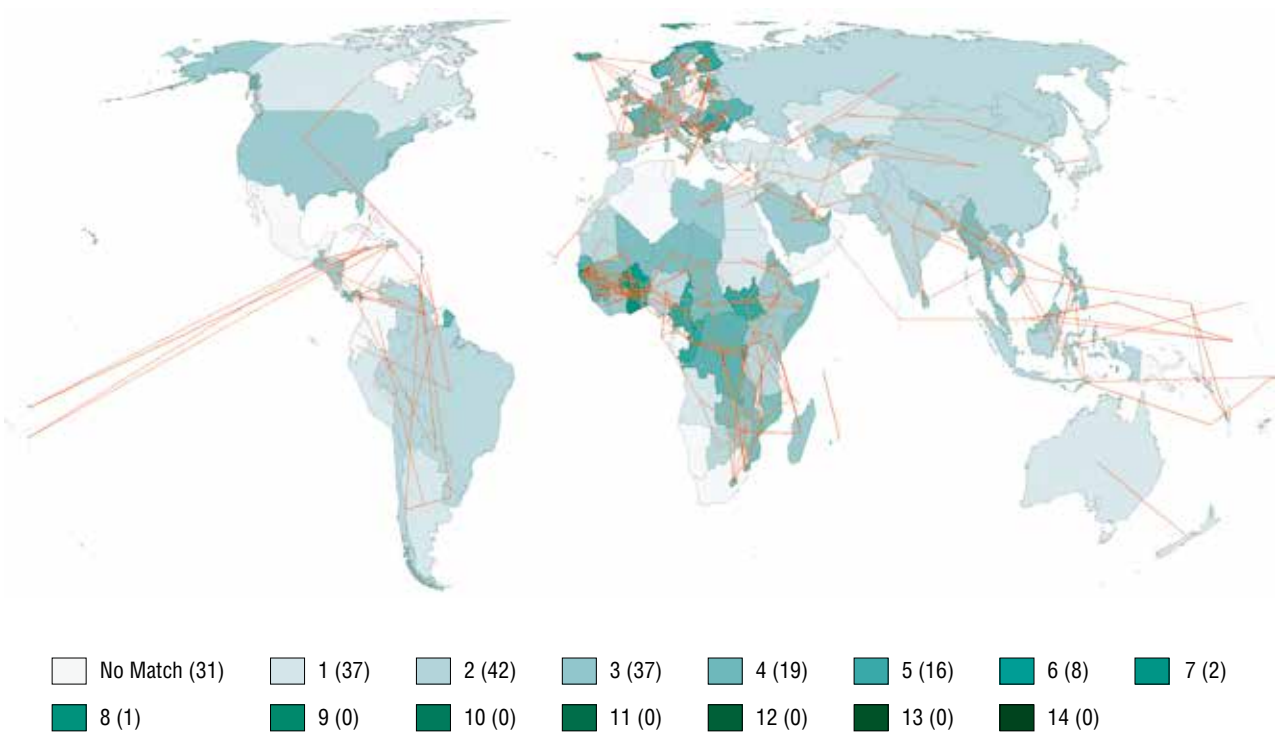


Fig. 8.2.2. Likelihood-ratio test for the “Number of doctors” parameter

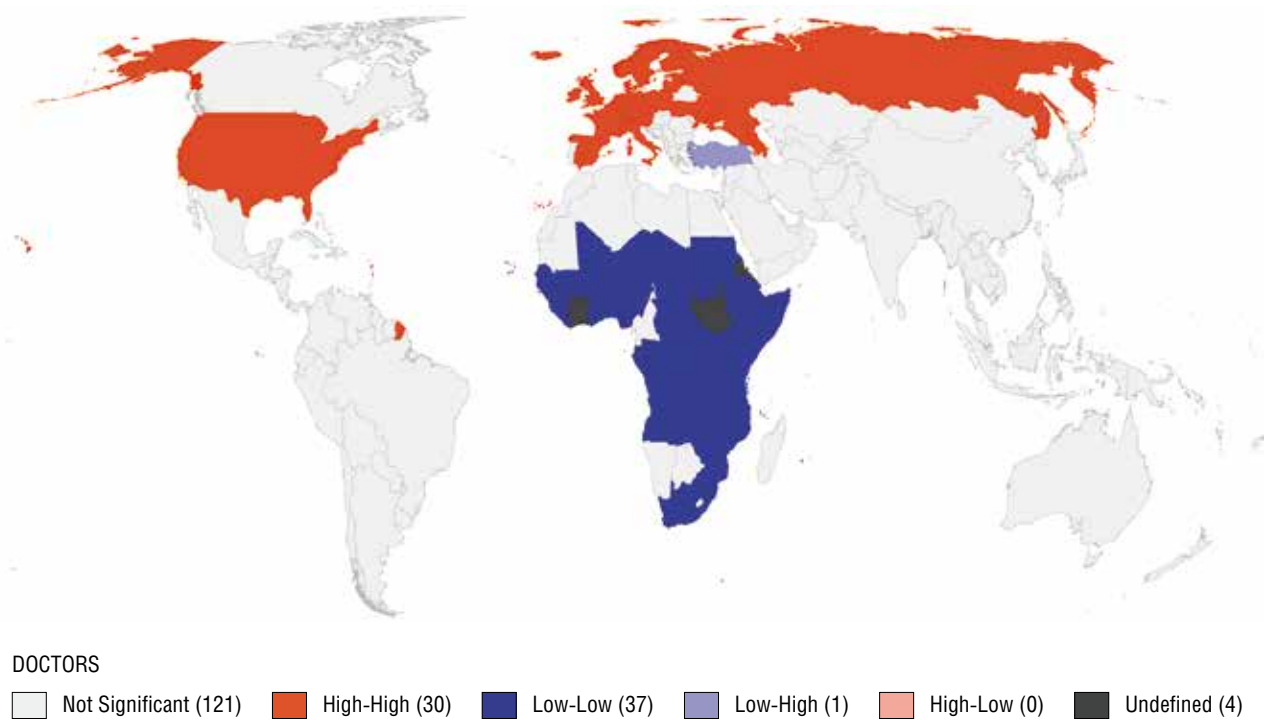


Fig. 8.2.3. “Number of doctors” spatial autocorrelation cartogram for the geometric neighbourhood matrix

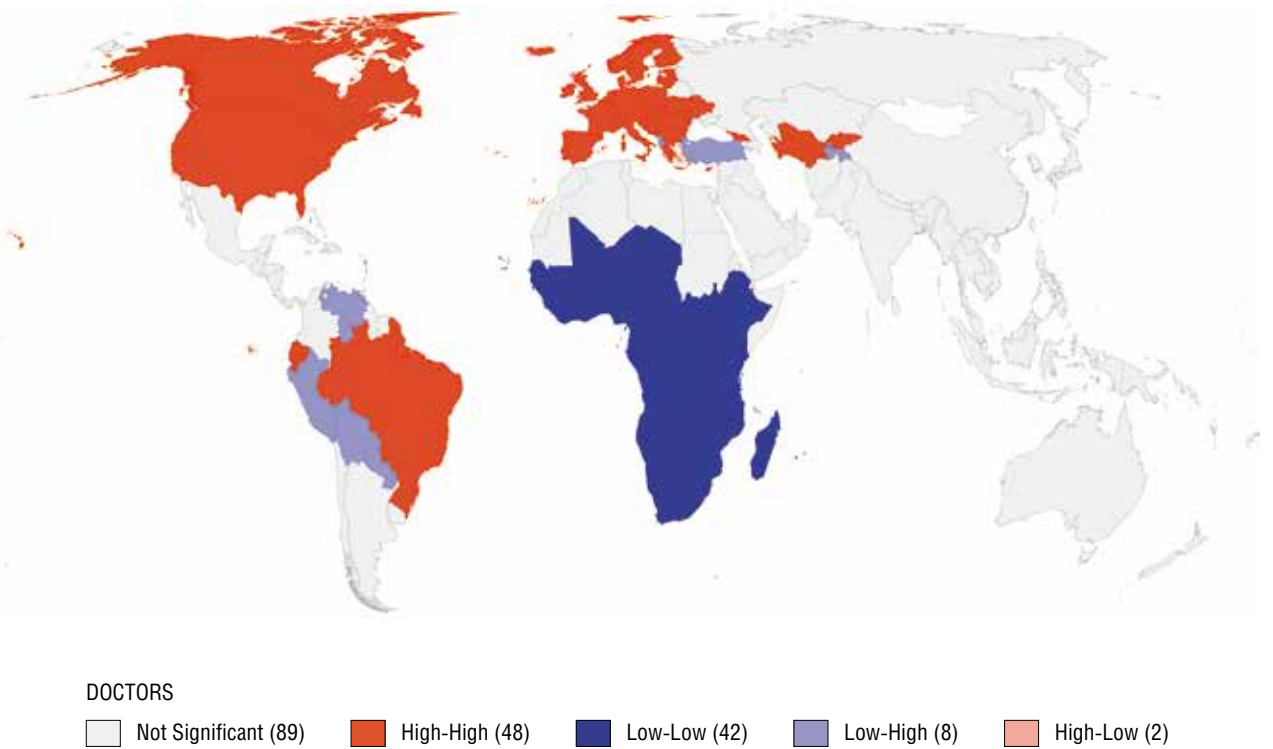


Fig. 8.2.4. “Number of doctors” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.3. Pharmaceutical exports

The pharmaceutical sector is a hi-tech sector whose development ensures successfully countering diseases and achieving longer life expectancy. Pharmaceutical exports reflect the competitiveness and relevance of national “Pharmas,” the country’s place in global added value chains. Large pharmaceutical exports indicate that the country is self-sufficient in high-quality medicines.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.309	0.000	0.189	0.000
Geary's C	0.706	0.000	0.807	0.000

The percentile cartogram (Fig. 8.3.1) shows that countries of Western and Central Europe have the highest values (and that includes the leader, Switzerland). We could also mention Israel, Lebanon and Panama, while India and the United States should be mentioned among large economies. Low values are typical for some African states, Mongolia, Afghanistan and East Asia.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world’s geopolitical structure has greater significance is thus not confirmed.

The pharmaceutical exports cartogram for the geometric neighbourhood matrix (Fig. 8.3.3) shows two main clusters: Western Europe and Africa. The Western European cluster includes countries that traditionally manufacture pharmaceuticals. For instance, Switzerland, the leading manufacturer of pharmaceuticals, is home to two of four largest pharmaceutical companies in the world (Roche and Novartis).

However, amid the coronavirus pandemic, despite their lower exports (in terms of GDP per capita), American, Russian and Chinese companies, which are more hi-tech when it comes to vaccine production, turned out to be better suited for rapidly manufacturing vaccines.

A somewhat fragmented cluster of African states (Madagascar, Malawi, Angola, Tanzania, and the Comoro Islands) includes countries that do not have mass pharmaceutical production. These countries are on the lower rungs of added value and are unable to produce their own medicines.

Global place	Country	Indicator (per mille)
1	Switzerland	85.93
2	Ireland	83.3
3	Belgium	79.7
Mean (30)	(Poland)	5.29 (5.28)
Median (75)	Brazil	0.71
139–149	Angola, Afghanistan, Comoro Islands, Congo, Laos, Mongolia, Myanmar, Palau, Samoa, Sudan, Sierra Leone	0

Tellingly, the countries that are the largest producers of generics (India, Israel, Brazil) do not form a spatial cluster. The European “pharma” specialization has emerged gradually. Unlike Europe, new manufacturers are less geared towards geographic proximity and rely rather on human capital and/or domestic demand.

The geopolitical neighbourhood matrix (Fig. 8.3.4) shows somewhat expanded clusters, but they essentially remain the same. Tellingly, the United States, one of the world’s largest manufacturers of pharmaceuticals, is in the “high-low” cluster because American companies are largely geared towards the domestic market and have poor international competitive edge in those cases when their medications have analogues: American-made medicines are more expensive due to the specific features of the social security system in the United States.

In this case, the geopolitical neighbourhood matrix clearly demonstrates certain anomalies, but generally does not have significant advantages compared to the geometric matrix.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Pharmaceutical exports” parameter (Fig. 8.3.2) shows deep correlations between European countries, thereby reflecting one of the foundations of European integration at its initial stages. As before, there is a major gap between Africa and the rest of the world, even though Africa has a dense system of internal correlations, particularly in Southeast Africa.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Debt inward FDI stock	0.037	0.045	0.284	2.190
2	Export	0.036	0.021	0.216	1.296
3	Number of doctors	0.142	0.000	0.394	1.094
4	Population growth	0.038	0.017	-0.200	1.058
5	Hospital beds	0.055	0.023	0.239	1.036
6	Economic inequality	0.063	0.005	-0.247	0.973
7	Bank deposits	0.046	0.013	0.208	0.946
8	Highly wealthy population	0.085	0.001	-0.284	0.944
9	Access to electricity	0.039	0.016	0.184	0.872
10	Elderly population	0.183	0.000	0.394	0.846

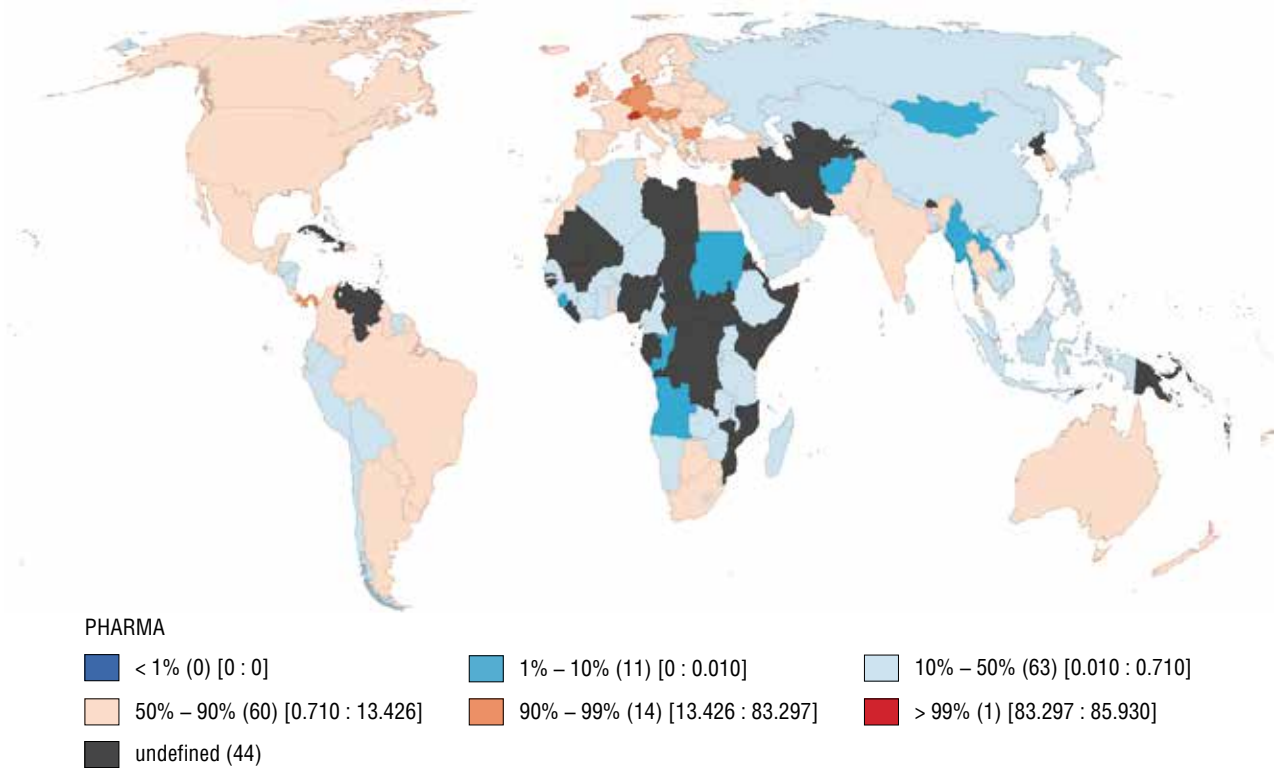


Fig. 8.3.1. Percentile cartogram for the “Pharmaceutical exports” indicator

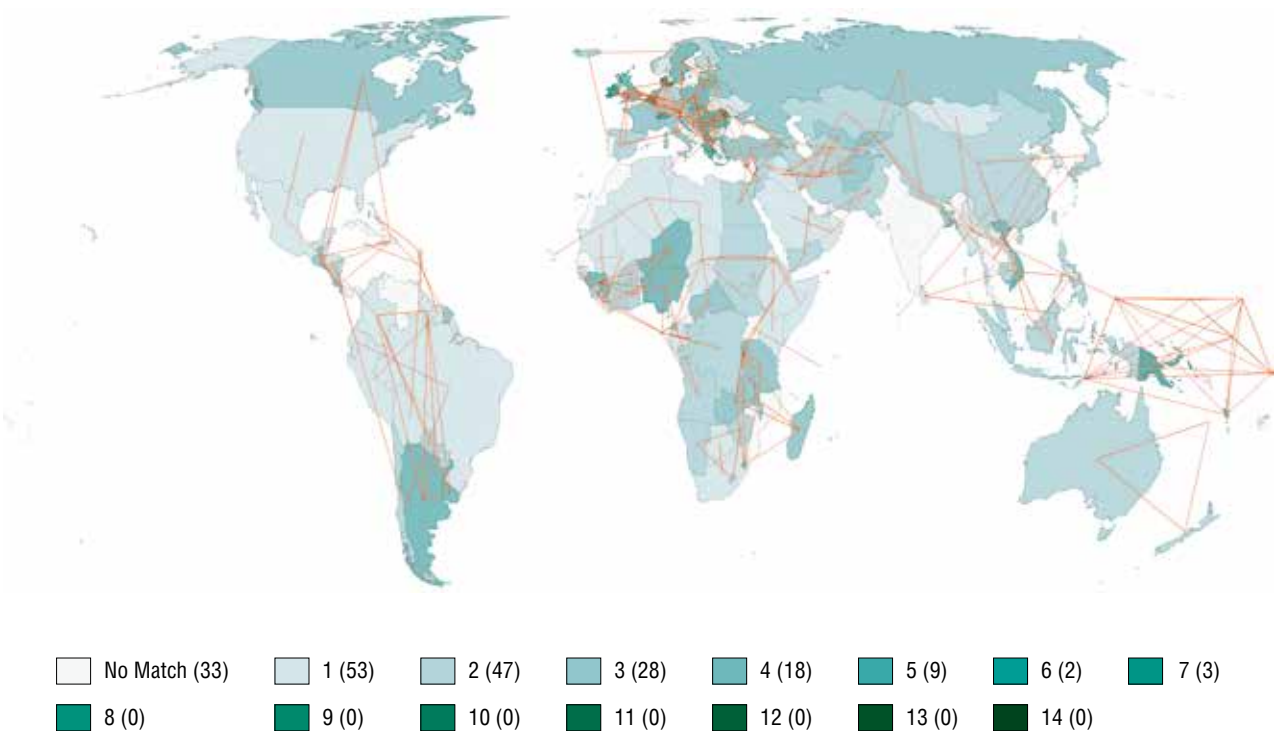


Fig. 8.3.2. Likelihood-ratio test for the “Pharmaceutical exports” parameter

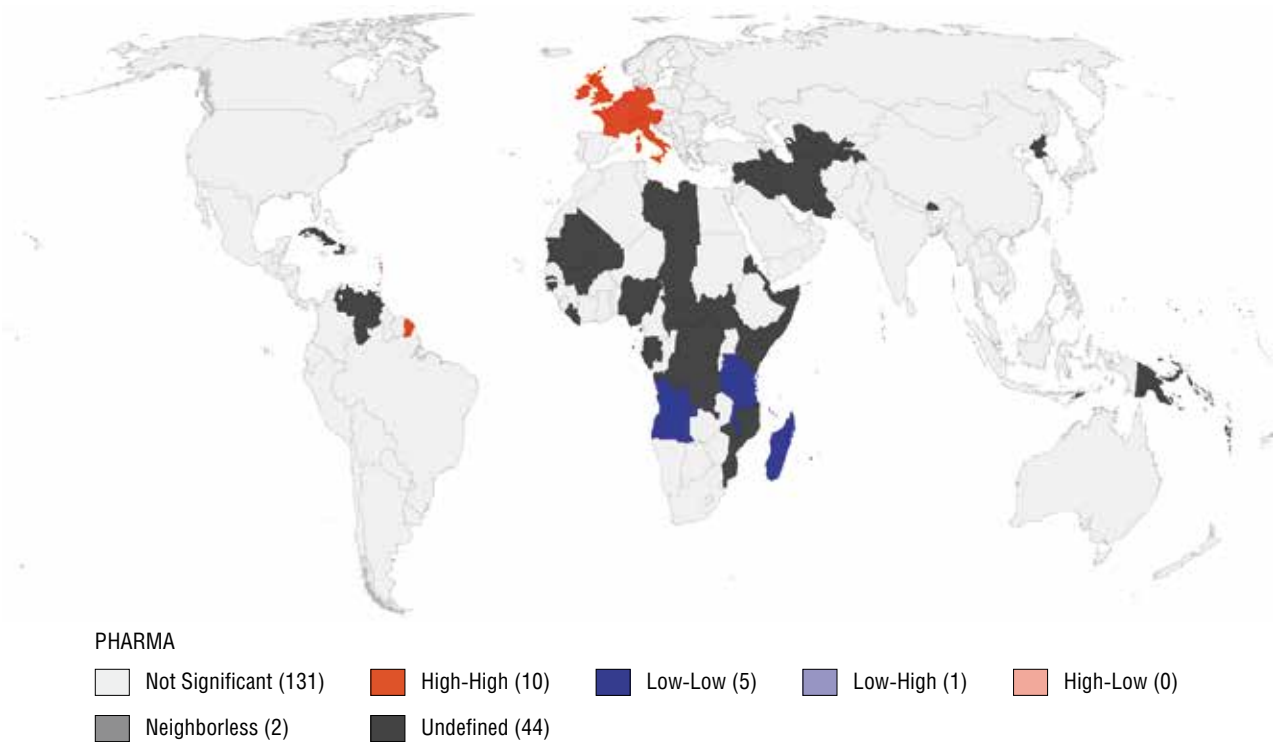


Fig. 8.3.3. “Pharmaceutical exports” spatial autocorrelation cartogram for the geometric neighbourhood matrix

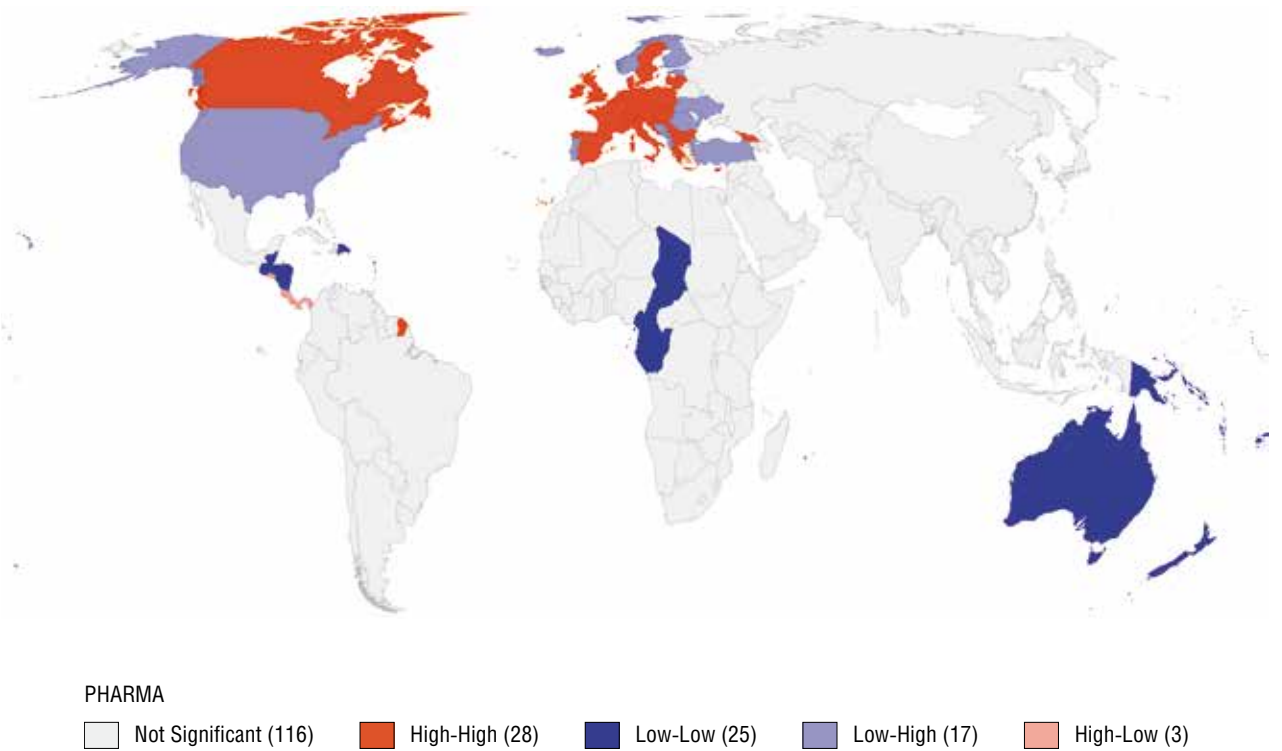


Fig. 8.3.4. “Pharmaceutical exports” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.4. Hepatitis B vaccinations

Hepatitis B is a viral disease that kills 700,000–900,000 people annually. The hepatitis B vaccine produces lasting immunity and is the most effective means of combating the disease. As of 2015, a total of 95% of countries have it on their vaccination schedule for newborns. Combating hepatitis B is an SDG component.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.202	0.000	0.065	0.010
Geary's C	0.748	0.000	0.930	0.010

The percentile cartogram (Fig. 8.4.1) shows best results in countries with a communist past, as well as in the oil-producing monarchies of the Persian Gulf, which have well-developed public healthcare systems. The worst results are shown by some countries of Africa and Oceania, as well as by Mexico and Ukraine.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.4.3) identifies two main clusters. Central Asia (with the exception of Turkmenistan and Tajikistan) is a cluster with high vaccination level. In Kyrgyzstan, the hepatitis B vaccination was put on the national vaccination schedule in 2000, consequently, high indicator values cannot be said to be the legacy of the Soviet healthcare system. Rather, they are a response to a real problem: the high incidence of this disease. At the same time, there are some doubts concerning the reliability of the data, since independent studies carried out in the past showed that countries of that region submitted unreliable statistics on childhood mortality due to the illness. Studies show that the main factor hindering the growth of this indicator is that mothers typically leave education following high school.

Central Africa (with the exception of Sudan) and part of East Africa form a cluster with low vaccination figures. This region is generally characterized by underdeveloped healthcare systems, poor education and, consequently, low awareness of the benefits of vaccination. However, the example of Chad shows that the key reason for the low vaccination figures lies in the fact that government institutions are simply unable to meet the requirements and cannot vaccinate the entire population, despite international efforts.

Global place	Country	Indicator (%)
1–22	22 countries	99
Median (88–96)	Armenia, Colombia, Dominican Republic, Cambodia, Kyrgyzstan, Netherlands, North Macedonia, Romania, Tunisia	92
Mean (121–123)	(Germany, Lesotho, Nauru)	87.07 (87)
182	Chad	46
183	Somalia	42
184	Papua New Guinea	36

Sudan is a notable exception, forming a cluster with a negative spatial correlation. Sudan was the first African country to introduce a “pentavalent vaccine” (2009) that includes hepatitis B vaccine. Given the relatively mass provision of medical care despite certain regional problems (in particular, Darfur), Sudan generally shows that its government institutions have greater operational capacities. Afghanistan is an example of the contrary — on the cartogram, it is represented as a low-value cluster.

The geopolitical neighbourhood matrix (Fig. 8.4.4) shows the same principal clusters with insignificant changes: Central Asia and Central Africa, although here they include fewer countries.

The main difference is the cluster of high values located in the Middle East and North Africa (from Morocco to the UAE). At the same time, a number of Arab League countries “drop out” of this cluster and form a mini-cluster “high-low”, these are primarily Syria and Yemen affected by conflicts. A little further south, the same kind of spatial dependence is observed for Somalia, and in the Middle East — for Afghanistan and Pakistan. In general, a high degree of conflict conditionality is recorded for the indicator. Once again, the conclusion is confirmed that, development-wise, the Middle East is one of the world’s most highly differentiated regions.

Despite correlation under the traditional spatial neighbourhood matrix having greater significance, interpreting the cartograms through the geopolitical matrix also yields additional facts for analysis.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Hepatitis B vaccinations” parameter (Fig. 8.4.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. In this case, Africa is curiously divided into three clusters that are connected internally, but not between each other (North Africa, Central and West Africa, Southeast Africa), while other regions generally do demonstrate some connectedness.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Population growth	0.033	0.014	−0.165	0.827
2	Highly wealthy population	0.027	0.048	−0.142	0.750
3	Rate of gross accumulation	0.026	0.037	0.118	0.527
4	Elderly population	0.046	0.005	0.153	0.514
5	Regional trade agreements	0.031	0.018	0.124	0.502
6	Availability of electricity	0.077	0.000	0.191	0.476
7	Linguistic diversity	0.089	0.000	−0.188	0.396
8	Economic inequality	0.036	0.021	−0.118	0.385
9	Young population	0.178	0.000	−0.260	0.380
10	Ethnic fractionalization	0.068	0.001	−0.159	0.374

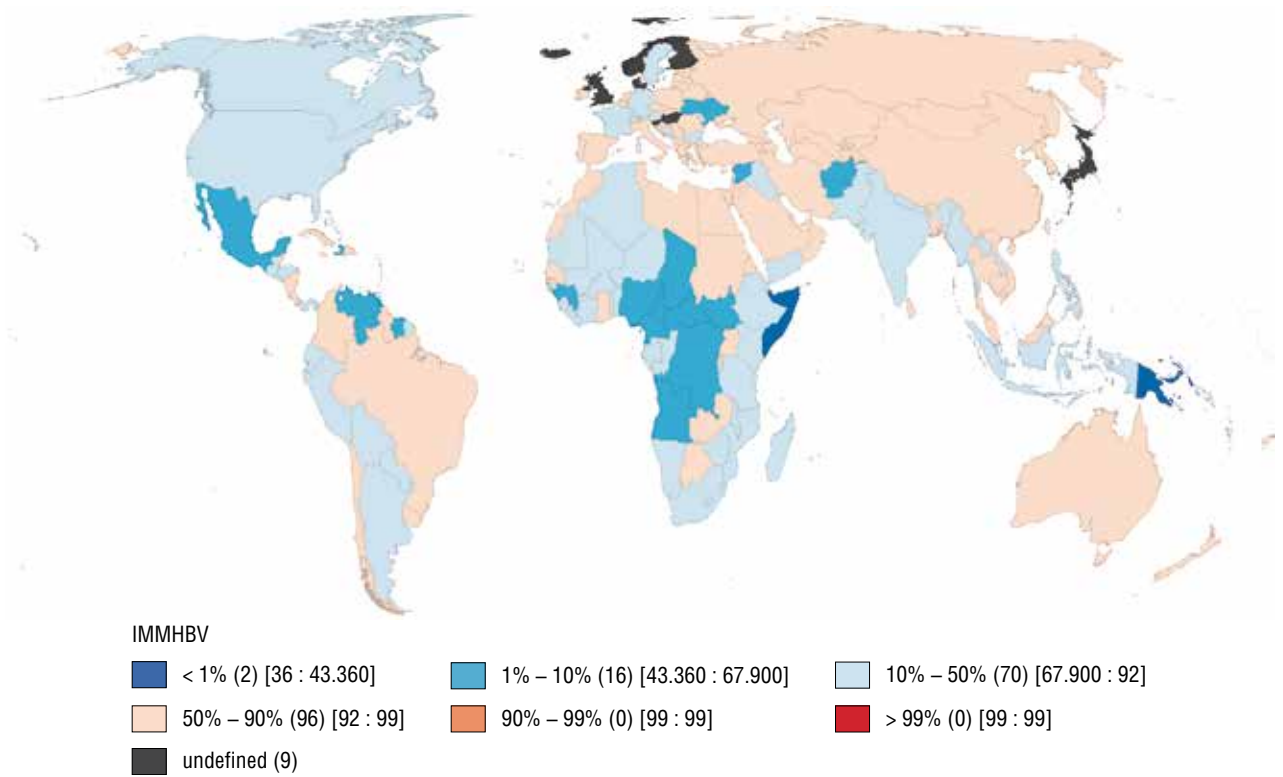


Fig. 8.4.1. Percentile cartogram for the “Hepatitis B vaccinations” indicator

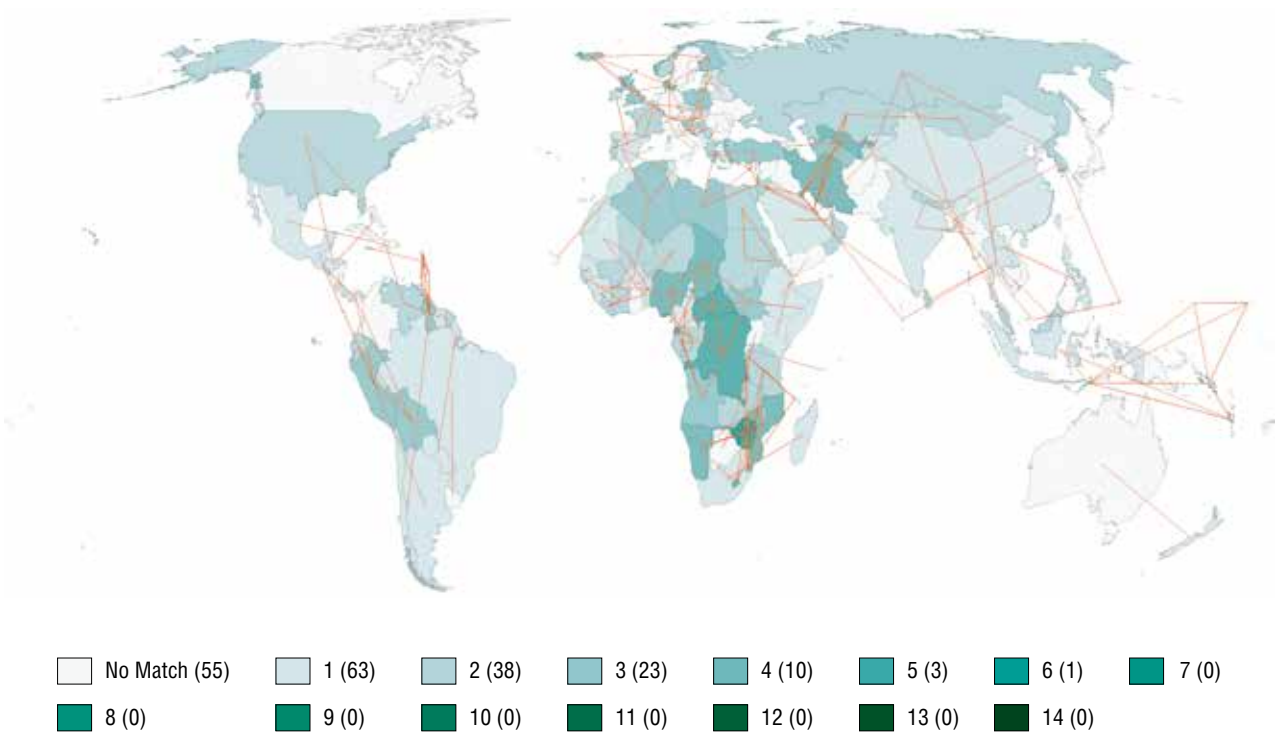


Fig. 8.4.2. Likelihood-ratio test for the “Hepatitis B vaccinations” parameter

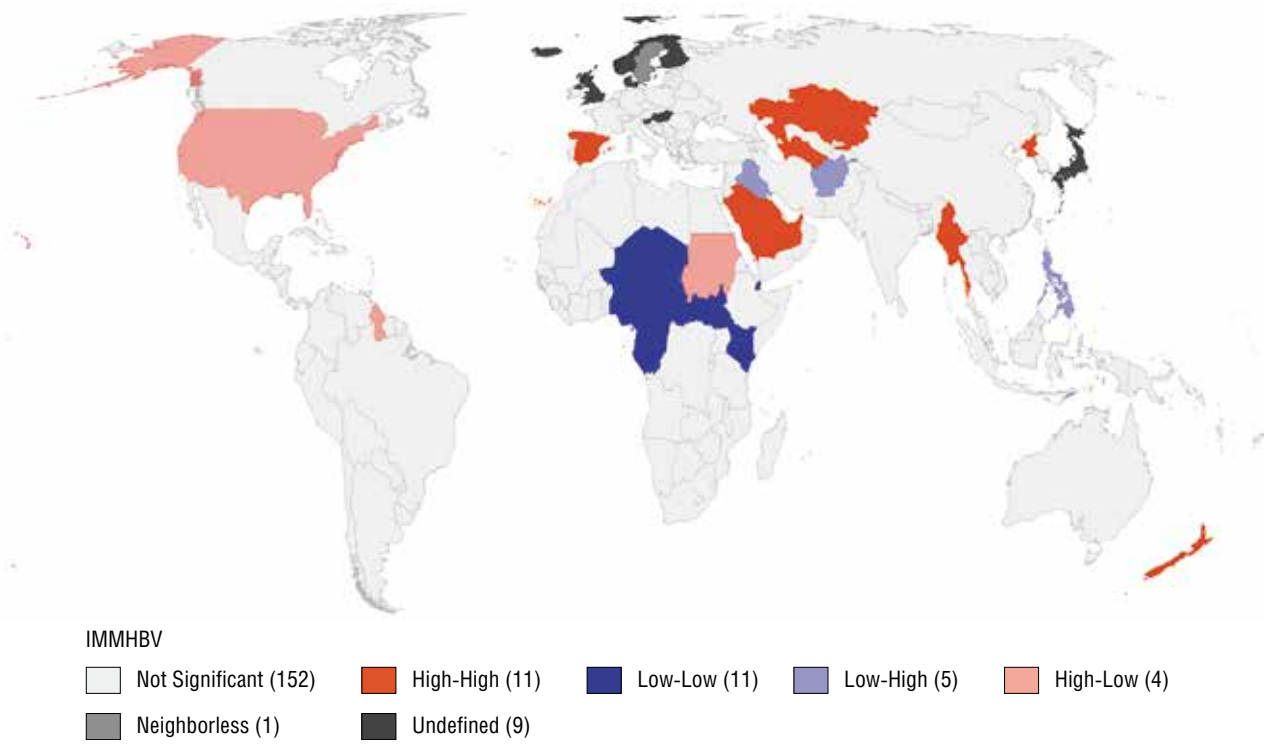


Fig. 8.4.3. “Hepatitis B vaccinations” spatial autocorrelation cartogram for the geometric neighbourhood matrix

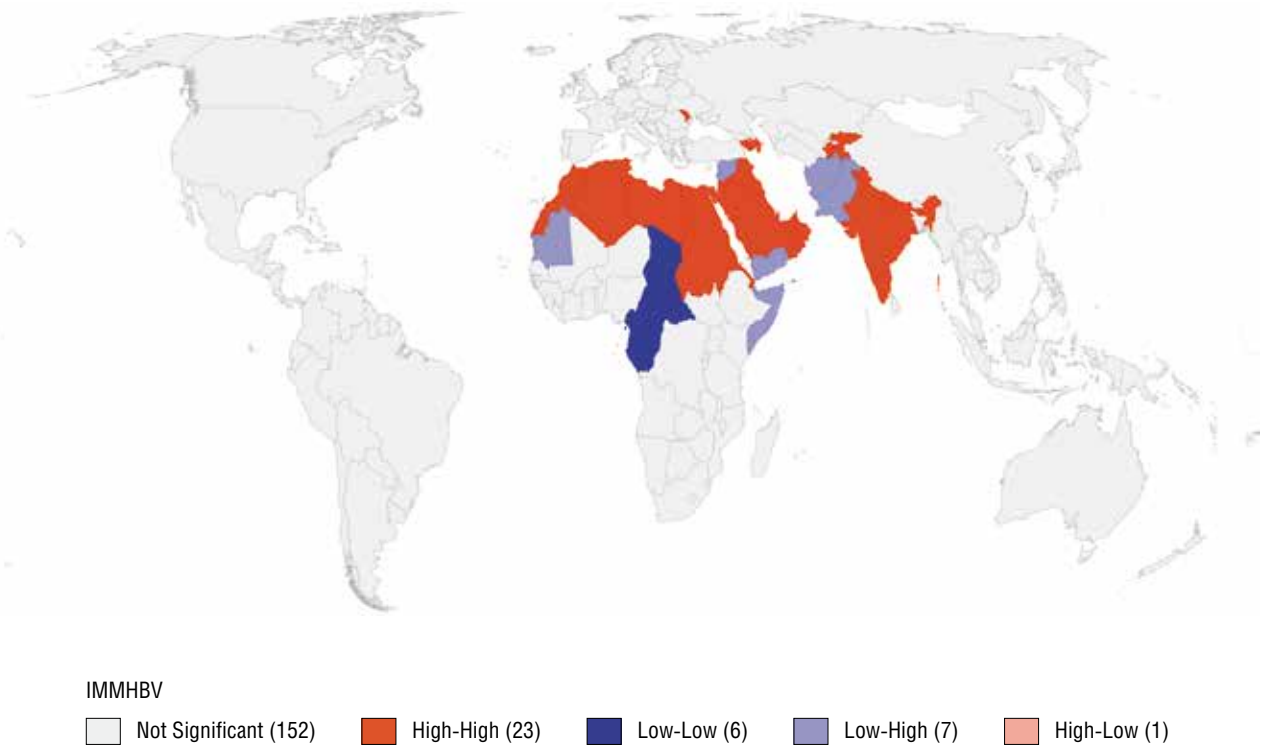


Fig. 8.4.4. “Hepatitis B vaccinations” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.5. Antiretroviral therapy (ART)

Antiretroviral therapy (ART) is a generally recognized method of treating HIV infections that has transformed a deadly disease into what might potentially become a chronic one. The therapy both reduces mortality and makes the virus less contagious. Currently, WHO strives to achieve 90% ART coverage as part of the campaign to stop the AIDS epidemic (this goal is part of the SDG).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.340	0.000	0.170	0.000
Geary's C	0.660	0.000	0.825	0.000

The percentile cartogram (Fig. 8.5.1) shows high accessibility of ART both in western countries that are part of the sampling (Italy, France, Spain, Ireland, Australia), and also fairly good results achieved in some sub-Saharan states due to international efforts. Countries of the Middle East and several large African states demonstrate the worst results.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.5.3) shows two clusters of high ART coverage. Western Europe includes countries where high national revenues provide states with resources required to make ART accessible to patients. On the correlation cartogram, this cluster includes only Ireland and France, but this is typical of other Western European countries, too, and the small size of the cluster is due to the lack of data for other countries.

The second important cluster is in Southeast Africa, including South Africa, but not Zambia and Madagascar. These are countries with low-to-medium incomes that receive international development financing and are capable of organizing the therapy. An important factor that has helped make medications more accessible to the populations of these countries is the appearance of "generics," which has reduced the costs of antiretroviral medications greatly. An important factor here is greater (greater even than in the US) percentage of regular compliance with medication intake schedule.

While clusters in Europe and North America can be ignored due to a lack of data for these regions, attention is drawn to a number of African countries that break out of the region-wide logic, forming

Global place	Country	Indicator (%)
1	Italy	90
2–3	Eswatini, Cabo Verde	88
Median (60)	Guatemala	54
Mean (62–63)	(Armenia, Bolivia)	52.9 (53)
117	Madagascar	10
118–119	Afghanistan, Pakistan	9

“low-high” clusters on the geopolitical neighbourhood matrix (Fig. 8.5.4): Madagascar, Mali, South Sudan, Angola, Liberia and Ghana. These countries have fewer HIV patients and have not become a focus of major injections of foreign financing, but on their own, they cannot always ensure effective operations of corresponding systems (or they do not consider it a priority).

Despite correlation under the traditional spatial neighbourhood matrix having greater significance, interpreting the cartograms through the geopolitical matrix also yields additional clusters for analysis.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Antiretroviral therapy” parameter (Fig. 8.5.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. In this case, Africa remains divided along the line running across the continent southwest to northeast.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Motorways	0.041	0.028	0.181	0.804
2	Institutional foundations of democracy	0.073	0.003	0.240	0.792
3	IMF voting power	0.108	0.000	0.290	0.780
4	Regional trade agreements	0.086	0.001	0.257	0.768
5	Particulate air pollution	0.088	0.001	-0.259	0.761
6	Unused export potential	0.140	0.000	0.310	0.685
7	Import	0.153	0.000	0.320	0.671
8	Industry	0.098	0.001	0.251	0.640
9	Export	0.135	0.000	0.293	0.637
10	Loans to domestic companies	0.128	0.000	0.281	0.619

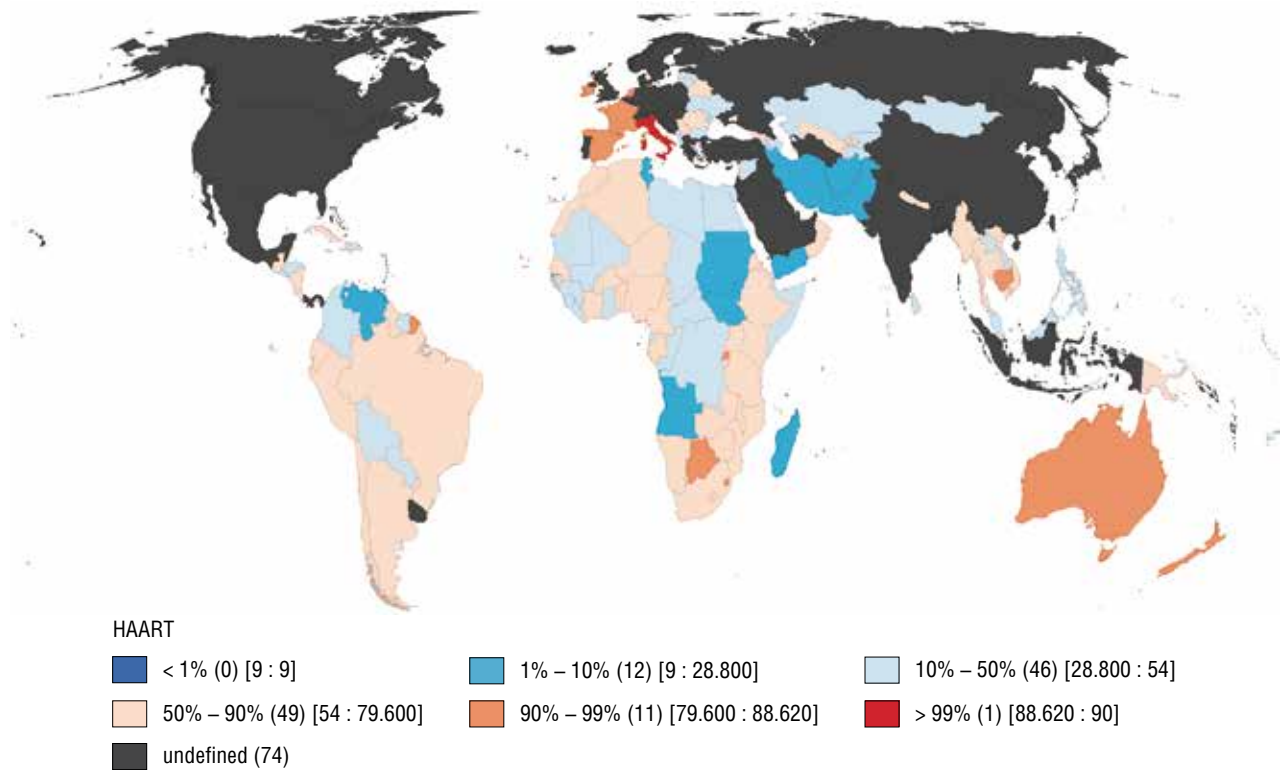


Fig. 8.5.1. Percentile cartogram for the “Antiretroviral therapy” indicator

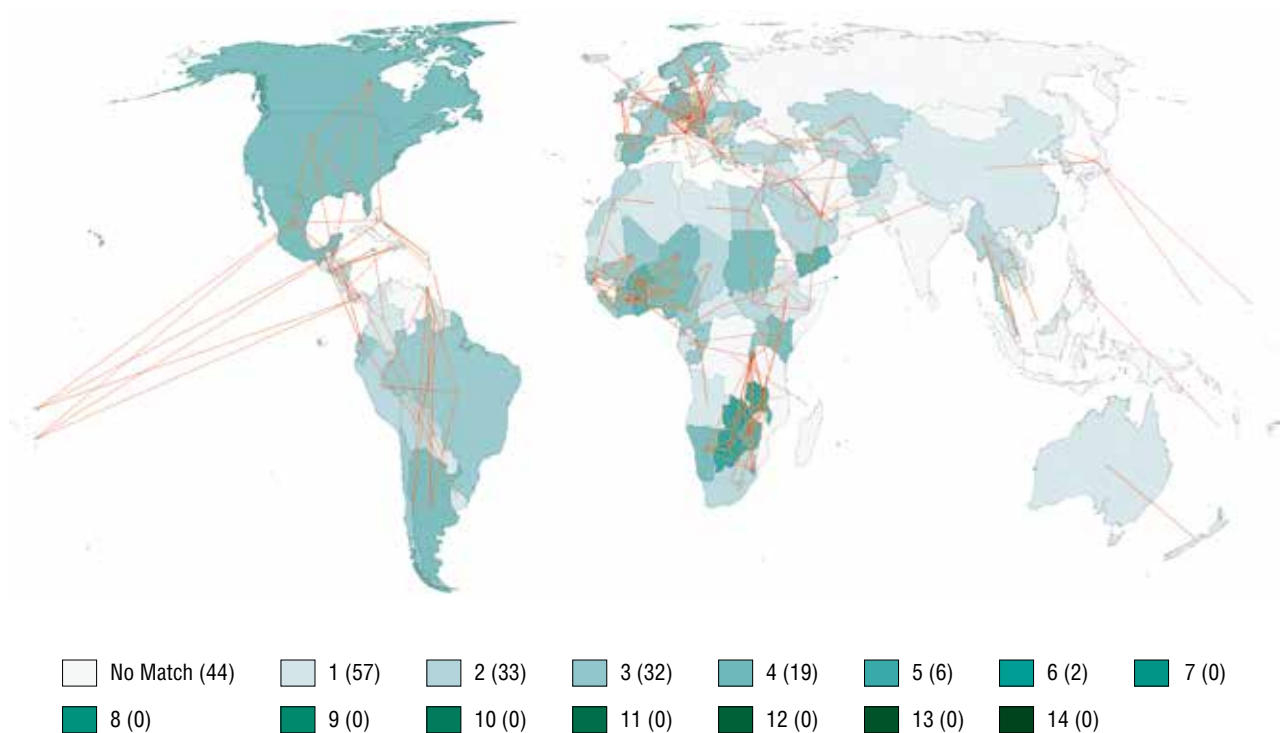


Fig. 8.5.2. Likelihood-ratio test for the “Antiretroviral therapy” parameter

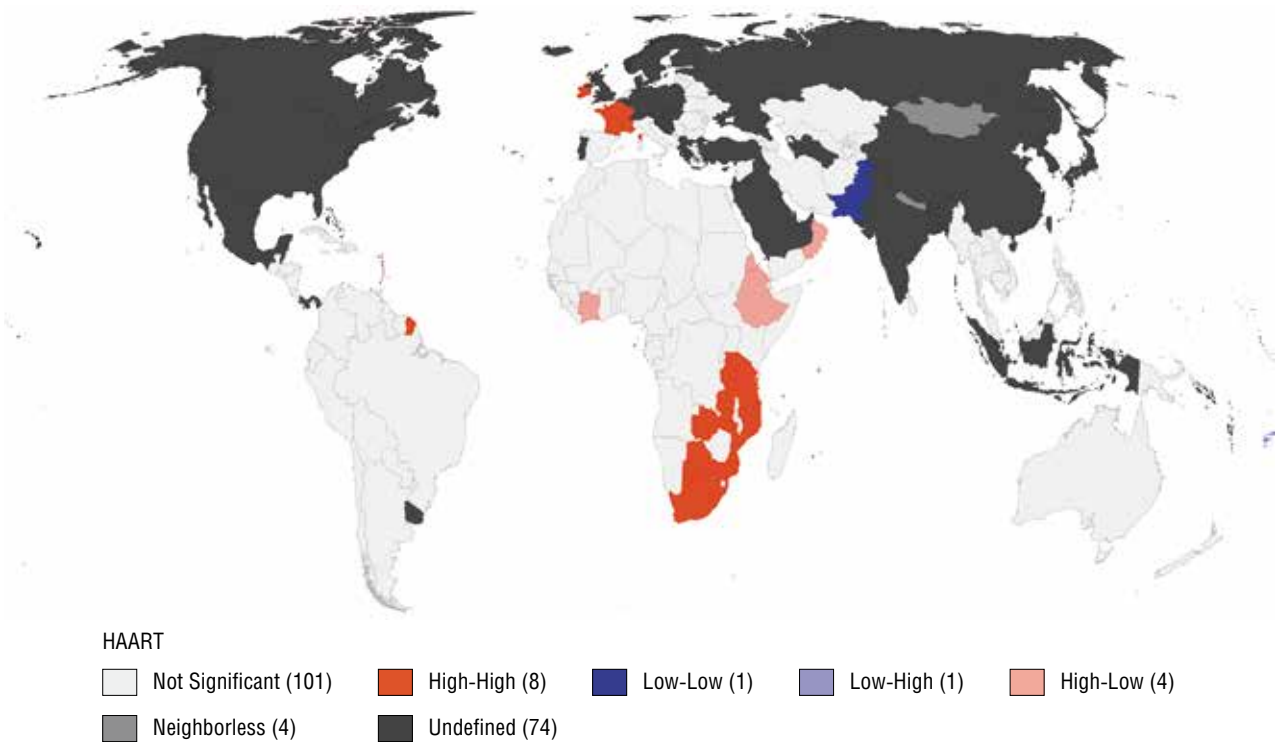


Fig. 8.5.3. “Antiretroviral therapy” spatial autocorrelation cartogram for the geometric neighbourhood matrix

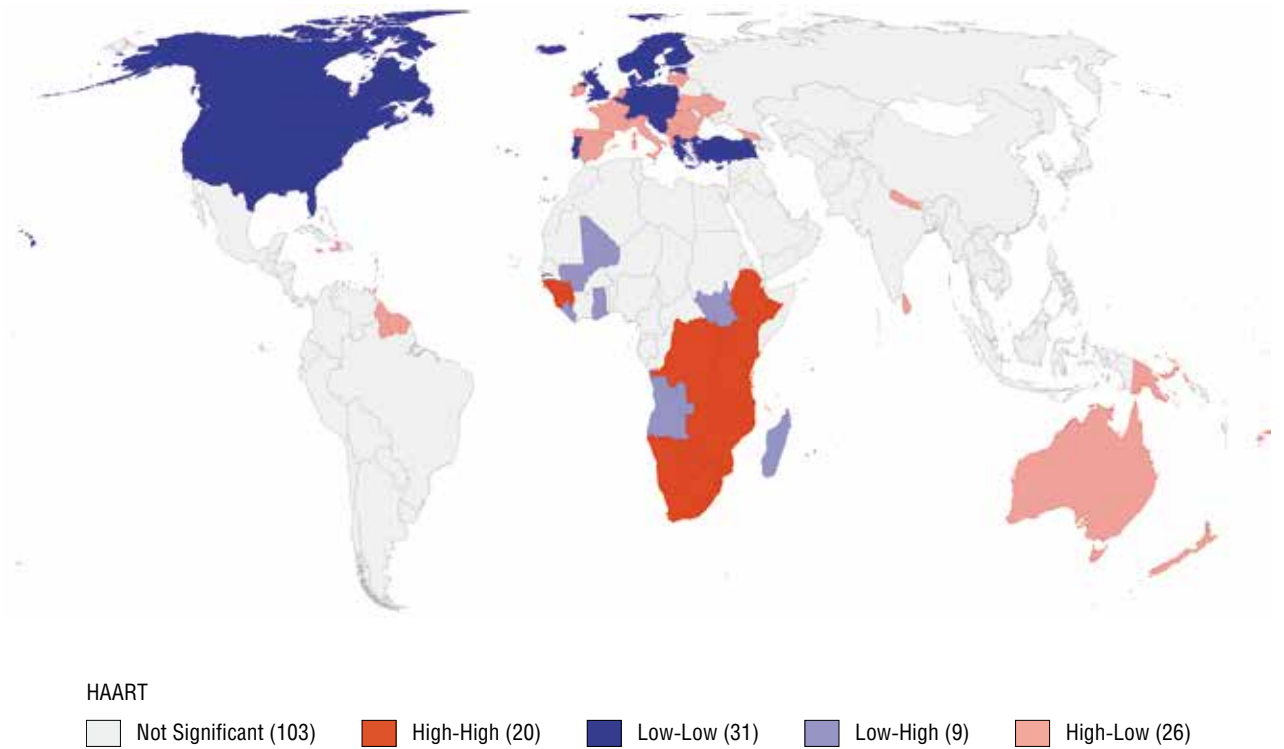


Fig. 8.5.4. “Antiretroviral therapy” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.6. HIV incidence

The human immunodeficiency virus (HIV) is an infectious disease that causes acquired immunodeficiency syndrome. As of 2021, the virus had killed approximately 36 million people. The third sustainable development goal “Good health and well-being” sets the target of ending the AIDS epidemic by 2030.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.834	0.000	0.471	0.000
Geary's C	0.139	0.000	0.526	0.000

The percentile cartogram (Fig. 8.6.1) shows that even though the situation is worst in Southern and Southeast Africa, HIV is a pressing problem for most global regions. The lowest HIV incidence is in the Middle East with Syria being the leader.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.6.3) shows four clusters. Southern and Southeast Africa form a high-value cluster that includes South Africa, Eswatini, Namibia, Botswana, Zambia, Zimbabwe, Mozambique and Malawi. The extent of the epidemic in these countries is due to the fact that its hotbed is in Africa, while underdeveloped healthcare systems prevented the diagnosis of the disease. For a long time, people had no information on the nature and ways of disease transmission.

Despite the generally stable positive spatial autocorrelation, the cluster with the highest values neighbours a “low-high” cluster that includes the Democratic Republic of the Congo and Angola. Researchers have no consensus concerning the causes of low HIV incidence in these countries: hypotheses range from male circumcision being useful in preventing infections to the negative effects that conflicts have on the spread of HIV.

Global place	Country	Indicator (per 100,000 population)
1	Eswatini	17,602
2	Botswana	16,858
3	Lesotho	16,128
Mean (23)	(Haiti)	1,375 (1348)
Median (61–62)	(Paraguay, Argentina)	297.05 (302; 292)
120	Sri Lanka	17
121	Comoro Islands	16
122	Syria	3

There are not enough statistics to draw any conclusions about Europe, where Albania, Montenegro and Serbia form a cluster with low HIV prevalence. The Syria and Libya cluster may have emerged due to cultural specifics. The latter conclusion is also supported by the existence of the large Islamic cluster of “low-high” values on the geopolitical neighbourhood matrix cartogram, which includes the Sahel, the Horn of Africa (except Ethiopia, where two thirds of the population belong to Christian denominations).

Other clusters on the two cartograms generally coincide. In this case, the geopolitical neighbourhood matrix cartogram is more informative and offers grounds for proposing and substantiating a larger number of hypotheses.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “HIV incidence” parameter (Fig. 8.6.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. In our case, we have also observed the isolated situation of North Africa. Curiously, it is the Democratic Republic of the Congo and Angola that are not consistent with the overall statistics, while virtually all their neighbours demonstrate high likelihood.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Young population	0.063	0.006	0.265	1.116
2	Tuberculosis morbidity	0.276	0.000	0.551	1.102
3	Female labour	0.048	0.016	0.224	1.055
4	School education quality	0.069	0.006	-0.267	1.037
5	Access to electricity	0.076	0.002	-0.273	0.979
6	Elderly population	0.054	0.010	-0.229	0.969
7	Highly wealthy population	0.315	0.000	0.552	0.967
8	Economic inequality	0.227	0.000	0.468	0.967
9	Infant mortality	0.076	0.002	0.270	0.964
10	Poverty	0.075	0.004	0.267	0.952

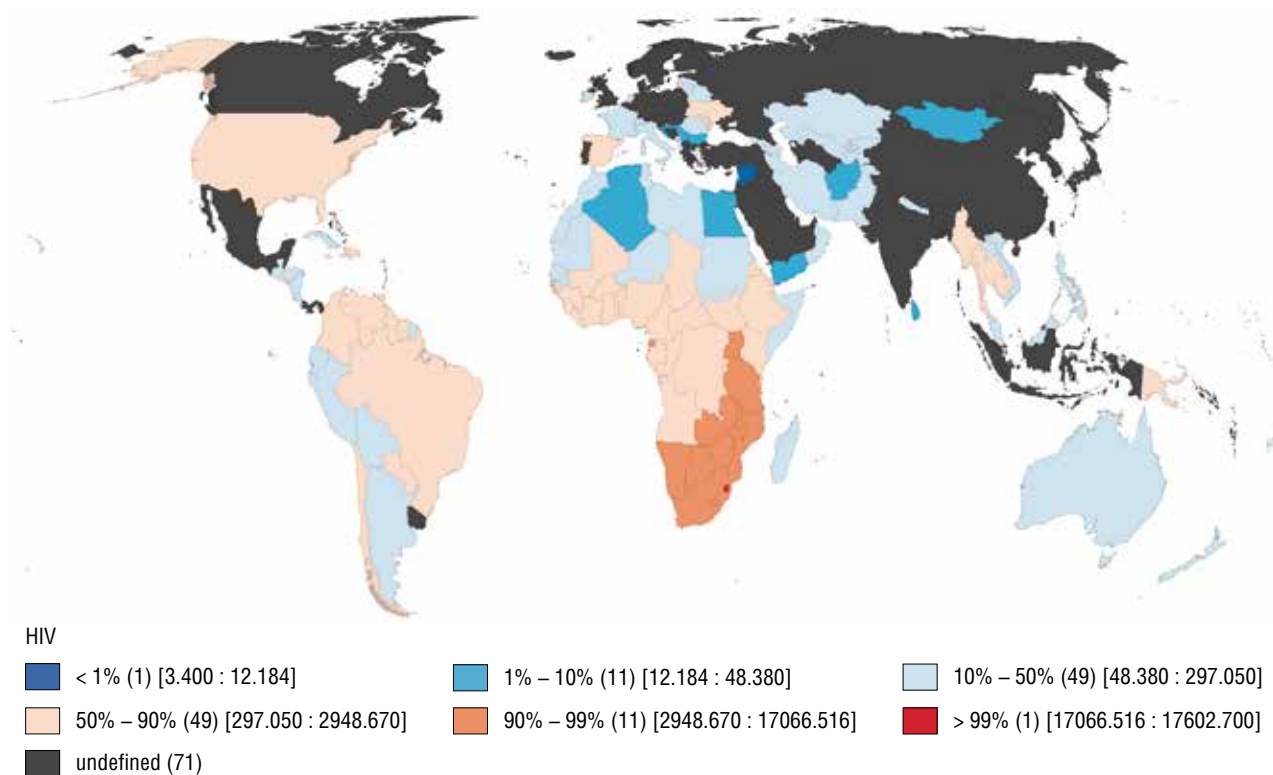


Fig. 8.6.1. Percentile cartogram for the “HIV incidence” indicator

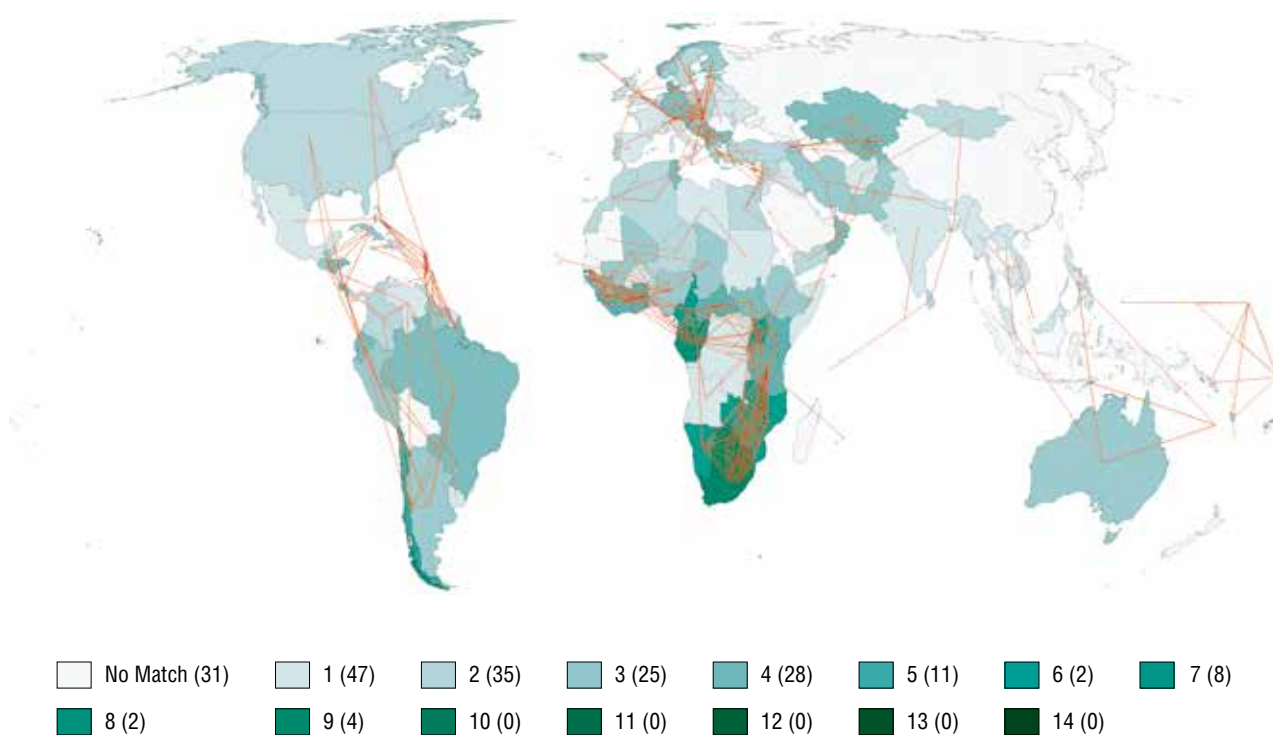


Fig. 8.6.2. Likelihood-ratio test for the “HIV incidence” parameter

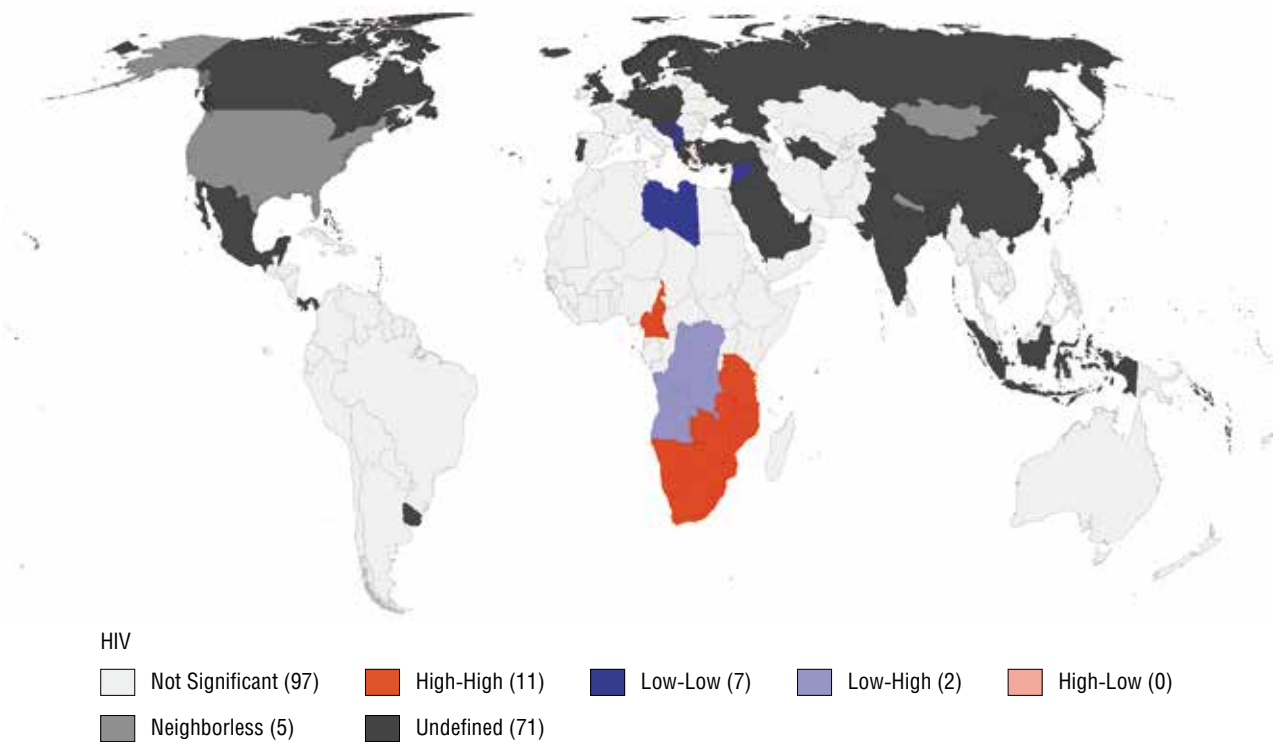


Fig. 8.6.3. “HIV incidence” spatial autocorrelation cartogram for the geometric neighbourhood matrix

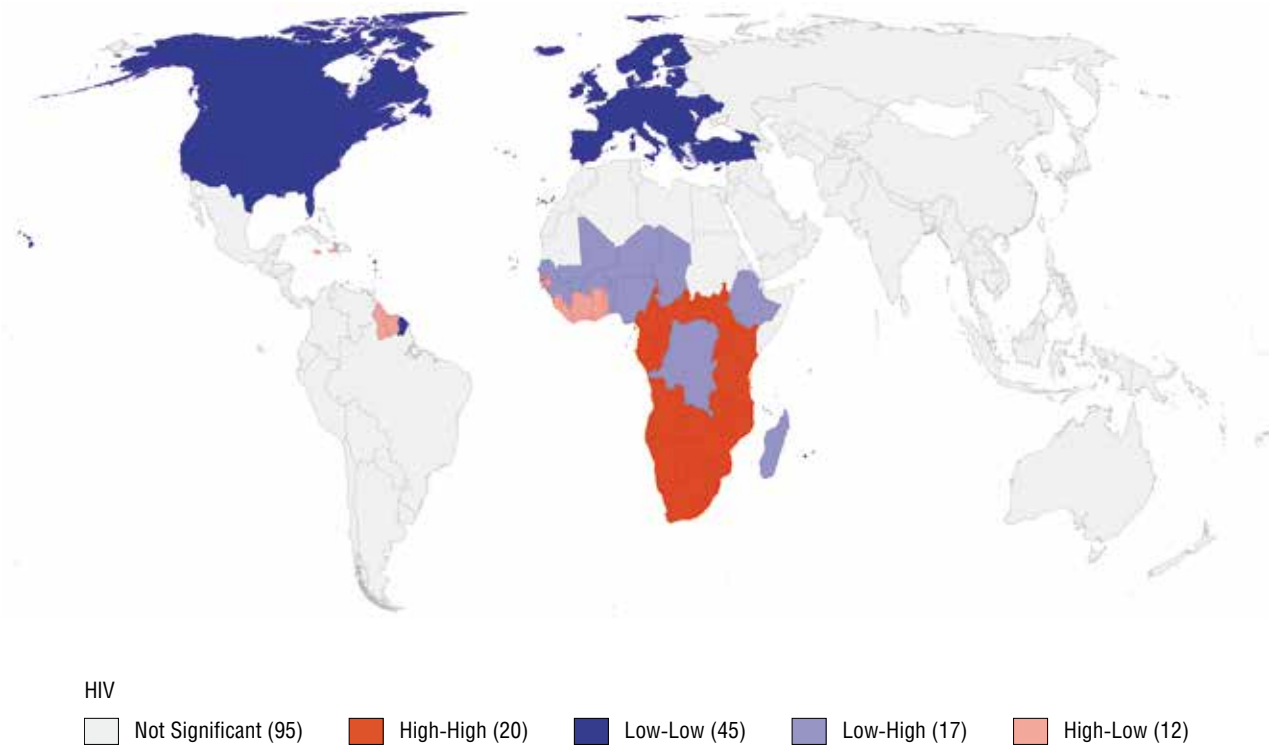


Fig. 8.6.4. “HIV incidence” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.7. COVID-19 mortality

The COVID-19 pandemic became a true stress test for healthcare systems around the world. The “Coronavirus mortality per 1000 cases” indicator allows the research team to conduct an inter-country assessment of the effectiveness of medical services from the point of view of combating viral diseases.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.066	0.052	0.11	0.000
Geary's C	0.901	0.164	0.885	0.000

The data represented on the percentile cartogram (Fig. 8.7.1) is rather fragmented. However, it is still possible to say that developed economies are more likely to have medium or low figures for COVID-19 mortality. We should note that in some instances, the data provided is likely invalid: low coronavirus mortality figures in Africa and in South Asia mostly stem from the lack of reliable statistics. Nevertheless, the figures for Singapore, the country with the lowest COVID-19 mortality, are likely reliable since they stem from one of the world's most efficient pandemic policies. Conversely, the case of Yemen, which has the highest COVID-19 mortality, also confirms that a healthcare system weakened by wars and humanitarian crises was not ready for the challenges of the pandemic.

The data represented on the spatial correlation cartogram for coronavirus mortality per 1000 cases for the geometric neighbourhood matrix (Fig. 8.7.3) forms two clusters: a high-value cluster and a low-value cluster. The high-value cluster is situated in Latin America, which is characterized by high population density and a large percentage of poor people, cultural traditions of active and close inter-group communication, weak healthcare systems (in some cases), and by the delayed response of governments to the pandemic, i.e., late decisions to introduce restrictive measures. The low-value cluster, which includes UAE and Qatar, is due to the rapid government response to the spread of the coronavirus infection and the early introduction of restrictive measures. These factors resulted in low contagion rates and, consequently, low COVID-19 mortality despite high population density.

Global place	Country	Indicator (persons)
1	Yemen	196.59
2	Peru	93.65
3	Mexico	92.36
Mean (87)	(Spain)	21.12 (21.17)
Median (111)	(Libya)	16.776 (16.49)
172	East Timor	2.59
173	Burundi	1.46
174	Singapore	0.575

The geopolitical neighbourhood matrix (Fig. 8.7.4) allows us to build spatial clusters of a larger scale: once again, the cartogram shows a large high-value cluster in South America that includes virtually all the MERCOSUR member states, while in the Eastern hemisphere, there is now a large heterogeneous cluster of high-low values that includes ASEAN+3 member states, as well as Russia, which neighbours them in the north, and Australia, which neighbours them in the south. Additionally, the cartogram expands the low-value cluster that now includes countries of Southeast Asia, Papua New Guinea, and New Zealand, an isolate. This data leads to interesting conclusions concerning geopolitical alliances: ASEAN+3 is highly heterogeneous since it includes both countries that are capable of efficiently counteracting the spread of the coronavirus infection and states whose decision-making systems, including in the part pertaining to healthcare, failed to develop an equally effective counteraction mechanism due to a different political culture. It is important to emphasize, however, that China's place in this cluster is not entirely justified since it promptly eliminated the hotbed of infection in its territory, and its high mortality rate is due to the fact that China was the first state where the pandemic struck.

The likelihood-ratio test for geometry and for the "COVID-19 mortality" parameter (Fig. 8.7.2) reveals a dense network of comparable values primarily in Europe, which is due to the region being highly integrated.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Ethnic minorities	0.026	0.038	0.153	0.9
2	Availability of electricity	0.027	0.032	-0.087	0.28
3	Religious diversity	0.06	0.001	-0.105	0.184
4	Unemployment	0.026	0.039	0.06	0.138
5	Loans to domestic companies	0.031	0.025	-0.063	0.128
6	GDP (PPP) per capita	0.037	0.013	-0.066	0.118
7	Internet users	0.026	0.033	-0.055	0.116
8	Women's unemployment	0.071	0	0.078	0.086
9	Rate of gross accumulation	0.025	0.045	-0.038	0.058
10	Conflictogenity	0.096	0	0.064	0.043

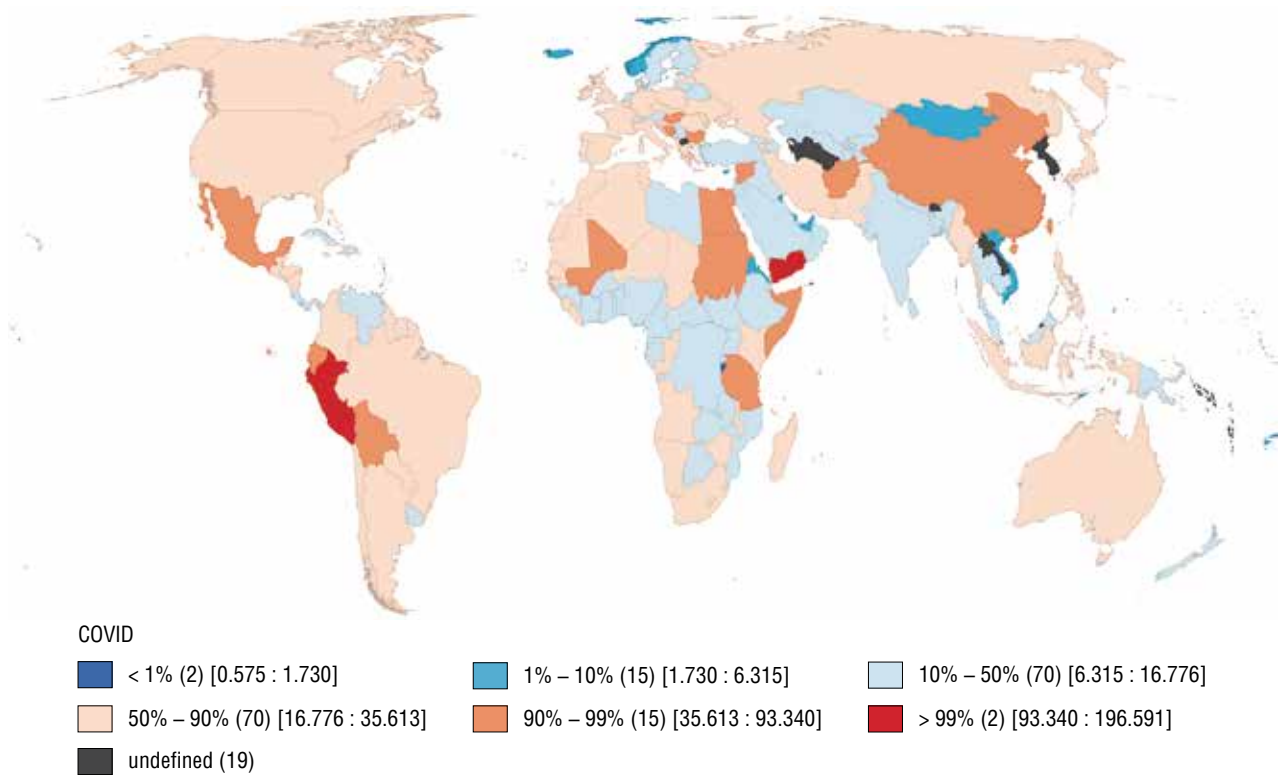


Fig. 8.7.1. Percentile cartogram for the “COVID-19 mortality” indicator

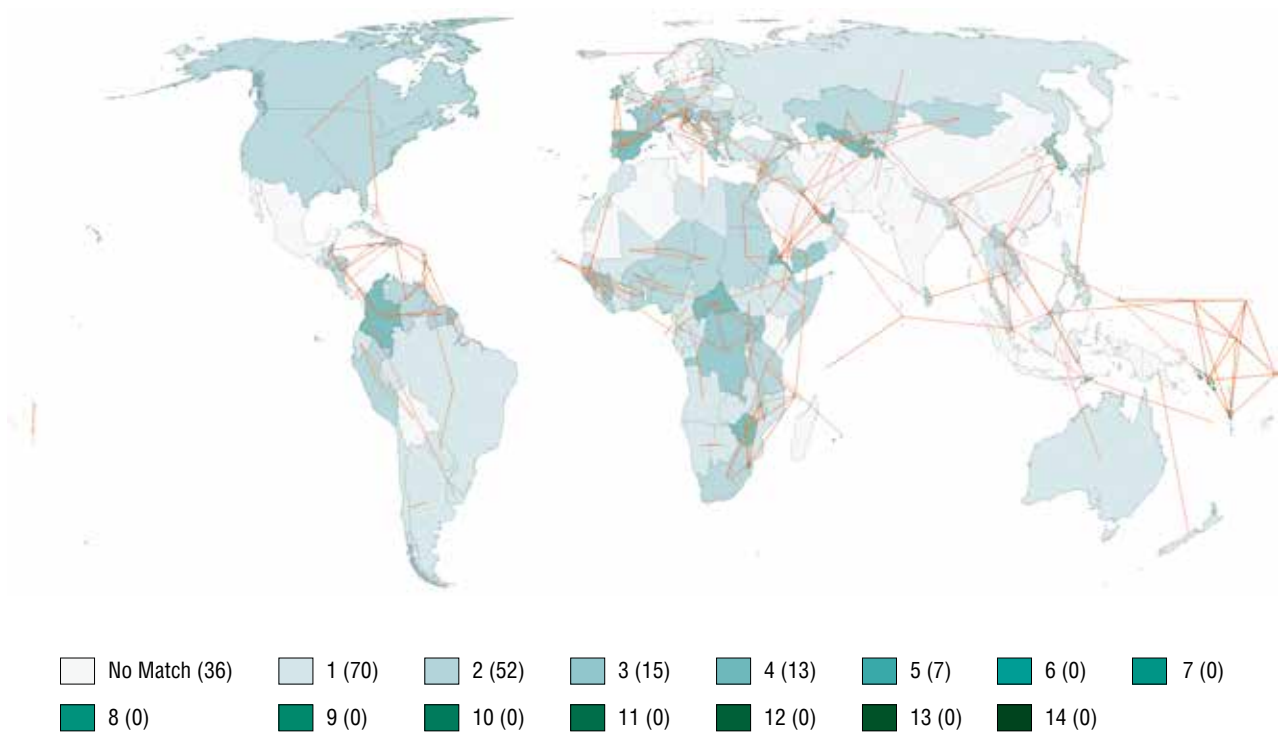


Fig. 8.7.2. Likelihood-ratio test for the “COVID-19 mortality” parameter

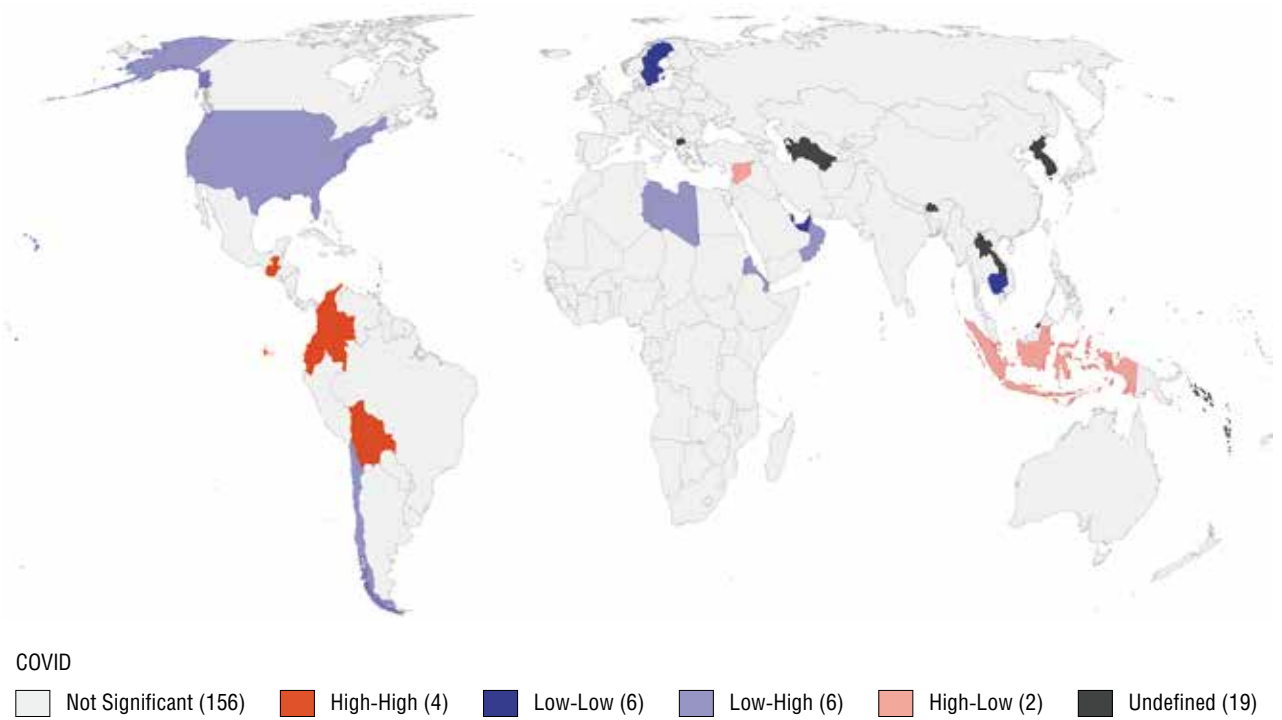


Fig. 8.7.3. “COVID-19 mortality” spatial autocorrelation cartogram for the geometric neighbourhood matrix

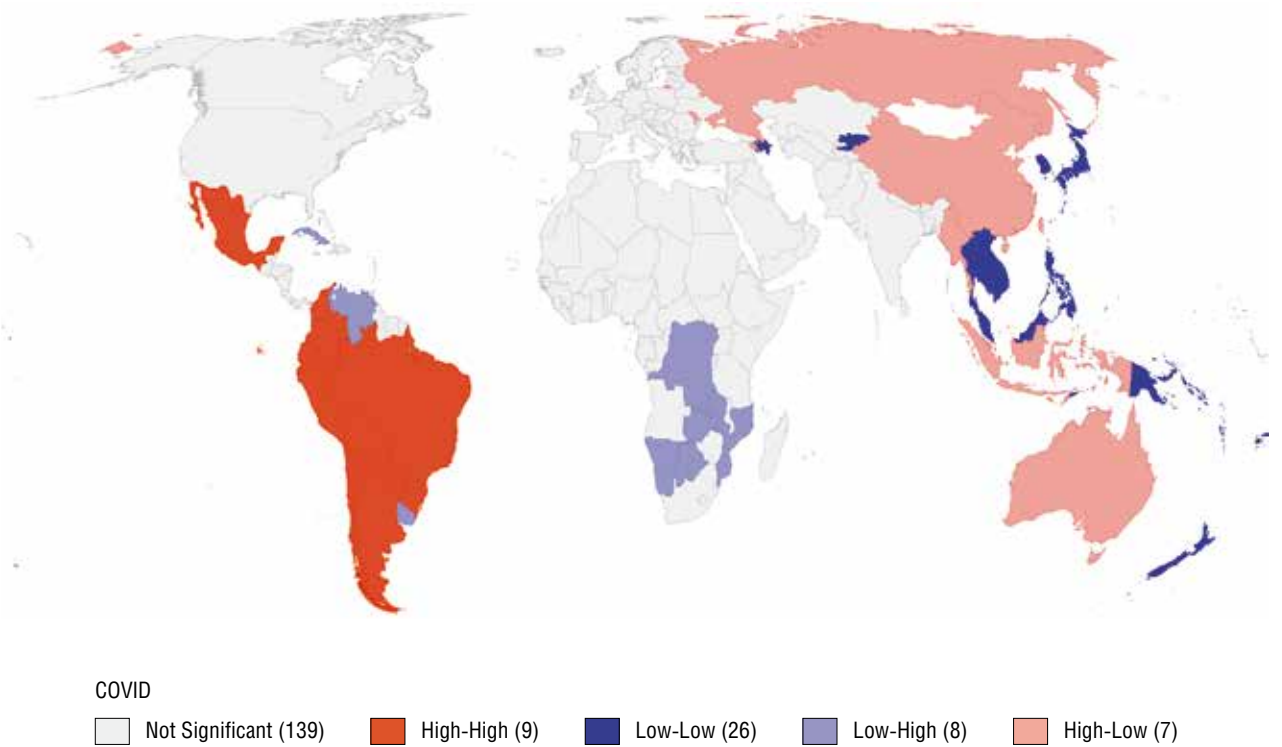


Fig. 8.7.4. “COVID-19 mortality” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.8. Tuberculosis morbidity

Tuberculosis is an infectious disease known to humanity since ancient times. It is one of the top ten causes of death in the world today. While over quarter of the global population carries the bacteria, actual tuberculosis cases stem primarily from socioeconomic factors and climate. Tuberculosis is a co-morbid condition for HIV. One of the SDG's health targets is to end the tuberculosis epidemic by 2030.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.533	0.000	0.468	0.000
Geary's C	0.448	0.000	0.529	0.000

The percentile cartogram (Fig. 8.8.1) shows high tuberculosis morbidity in sub-Saharan Africa and in Southeast Asia. These are hot and humid regions with low incomes for the population. Low morbidity figures are recorded in Europe, particularly in Northern Europe, and North America.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.8.3) shows five principal clusters: three low-value clusters and two high value ones. A low-value cluster includes the Lesser Antilles. These positive indicators compared to some Latin American countries include the high GDPs of these islands, basic sanitary conditions and food availability. The second low-value cluster includes Europe (with the exception of Eastern Europe, Spain, Greece and Portugal). It is important to note that the high tuberculosis rates in the European Union (28% as of 2013, and the figure is even higher in Western Europe) is due to imported cases, i.e. lower indicator values in France and Germany compared to Northern Europe are due to higher influxes of migrants. The fact that countries of Southern and Eastern Europe are absent from the sampling is likely because of their lower incomes. Their values, however, remain below global averages. The third cluster is located in the Middle East, where low figures are due to both high quality of life in oil-producing countries and to the dry climate.

Countries of sub-Saharan Africa form a high-value cluster. These are underdeveloped countries mostly with a very humid climate, something that is conducive to the spread of the disease.

Southeast Asia (with the exception of Malaysia, Thailand, Cambodia and the Philippines) is another concerning region that is still a standout despite the efforts of WHO, international aid (which covers about

Global place	Country	Indicator (per 100,000 population)
1	Lesotho	611
2	Philippines	554
3	Mozambique	551
Mean (60)	(Palau)	108.86 (109)
Median (96–98)	Vanuatu, Cabo Verde, Turkmenistan	46
190–192	Monaco, San Marino, Liechtenstein	0

one third of all expenses), and the fact that the number of cases has halved since 1990. The cluster emerged due to humid climate, low quality of life, and problems with sanitation. The same problems are typical for India.

The geopolitical matrix (Fig. 8.8.4) shows a Euro-Atlantic cluster of low morbidity, and high morbidity clusters in Southeast Asia (with the exception of China, Malaysia, and Japan) and Africa. Despite great significance of correlation under the traditional spatial neighbourhood matrix, geopolitical matrix clusters are more pronounced.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Tuberculosis morbidity” parameter (Fig. 8.8.2 identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. This case shows Africa’s isolation from the rest of the world.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Female labour	0.057	0.001	0.249	1.088
2	Cultural solidarity	0.113	0.000	-0.345	1.054
3	Number of doctors	0.227	0.000	-0.424	0.792
4	Linguistic diversity	0.156	0.000	0.345	0.762
5	Population growth	0.105	0.000	0.274	0.713
6	Institutional foundations of democracy	0.070	0.000	-0.224	0.712
7	Economic inequality	0.161	0.000	0.338	0.708
8	HIV incidence	0.276	0.000	0.439	0.699
9	Highly wealthy population	0.207	0.000	0.380	0.699
10	Regional trade agreements	0.122	0.000	-0.286	0.672

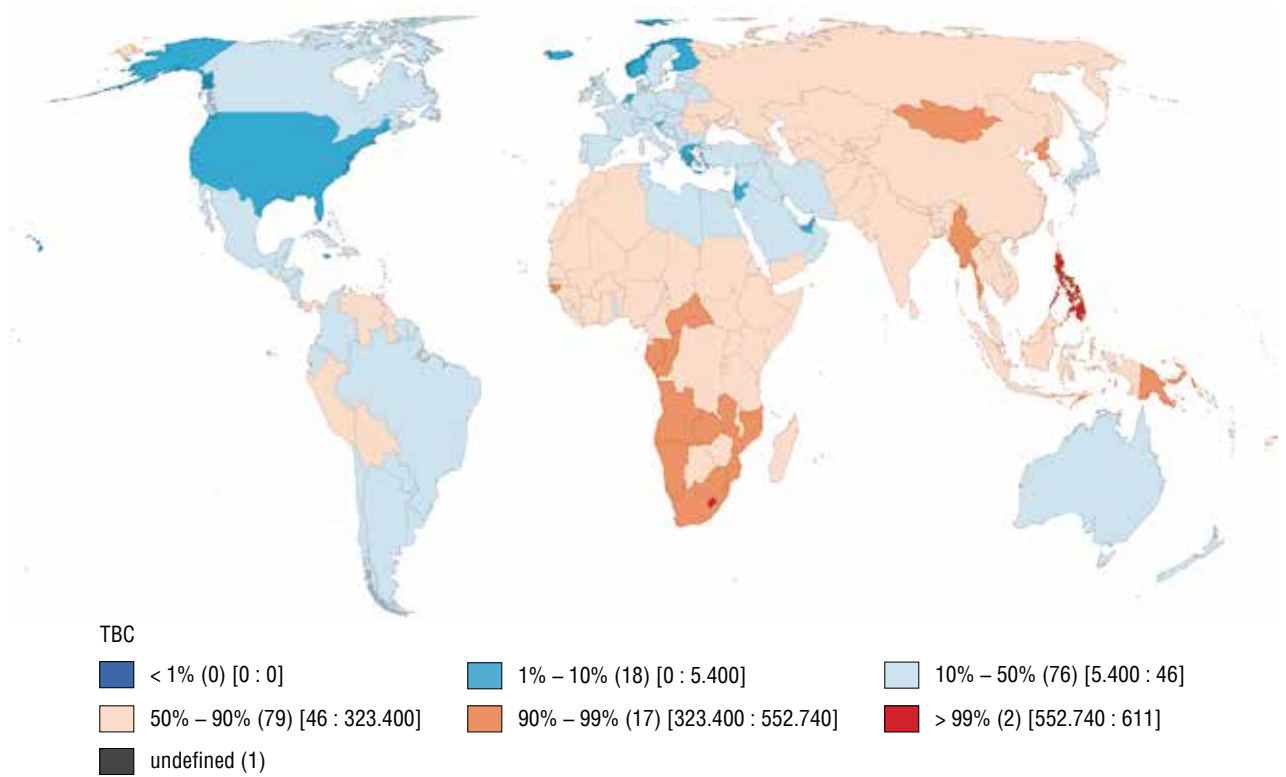


Fig. 8.8.1. Percentile cartogram for the “Tuberculosis morbidity” indicator

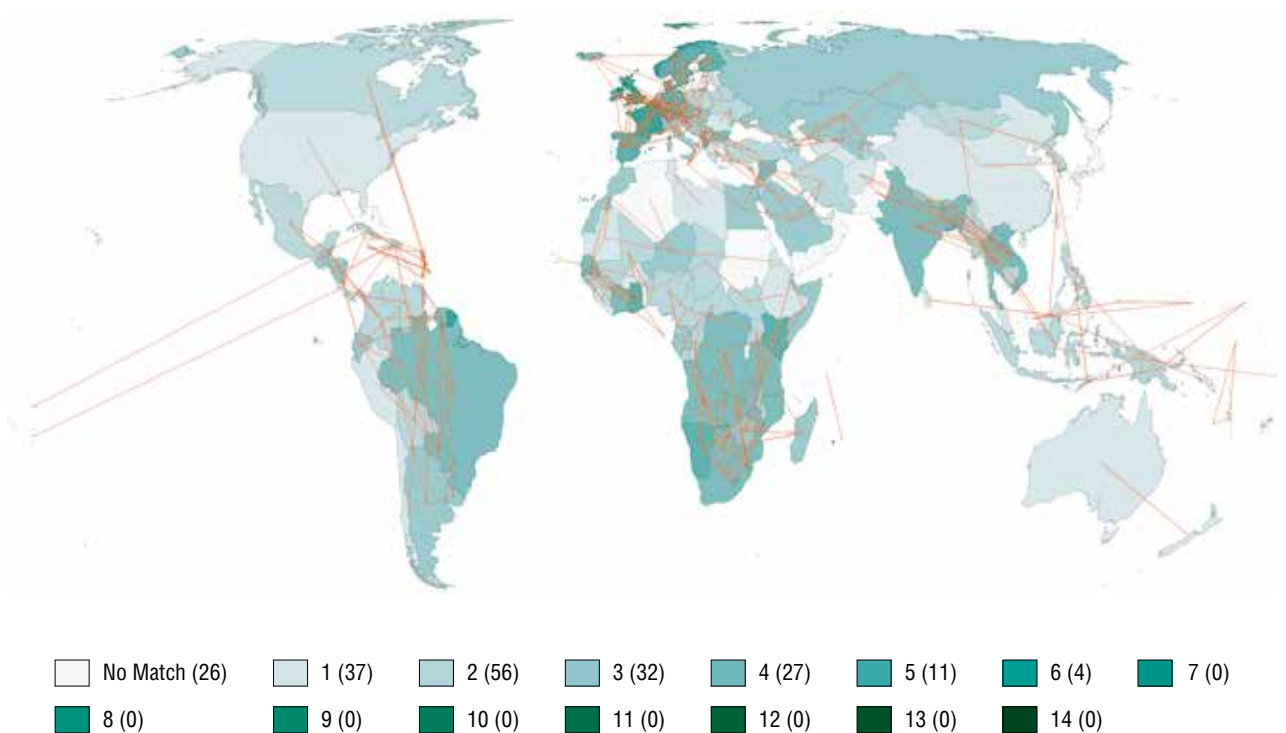


Fig. 8.8.2. Likelihood-ratio test for the “Tuberculosis morbidity” parameter

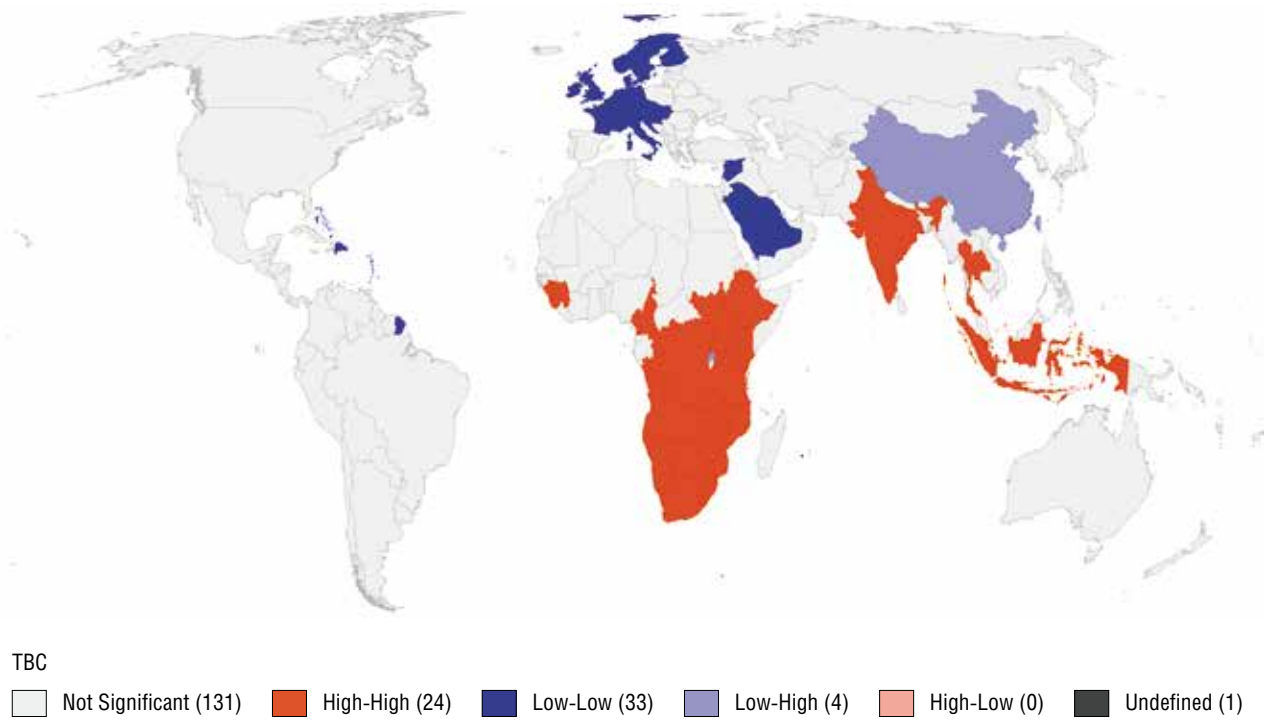


Fig. 8.8.3. “Tuberculosis morbidity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

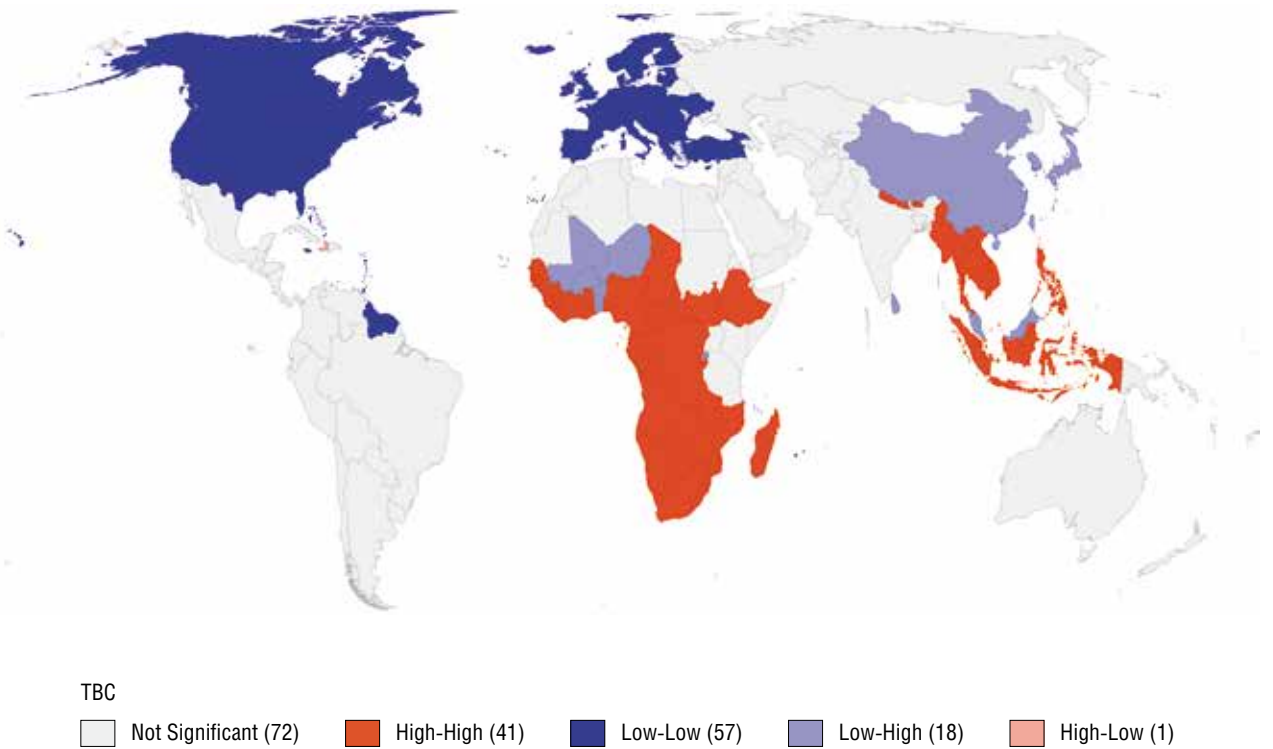


Fig. 8.8.4. “Tuberculosis morbidity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.9. Alcohol consumption

Recorded per capita, alcohol consumption is part of the basic indicators intended to trace the scale, nature and patterns of adult alcohol consumption, which is detrimental not only to health, but also to the social and economic wellbeing of individuals and their families, and society at large.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.506	0.000	0.377	0.000
Geary's C	0.495	0.000	0.625	0.000

The percentile cartogram (Fig. 8.9.1) shows that countries with the highest indicator values are concentrated in Europe, a region where alcohol consumption is part of the culture, while low values are typical for countries with mostly Muslim populations, where religion prohibits the consumption of alcohol.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.9.3) shows two clusters: a cluster with high per capita alcohol consumption and one macro-cluster of low values. The high-value cluster includes European countries, which is explained by the cultural traditions of their populations. On the contrary, the macro-cluster of low values includes states with mostly Muslim populations, which adhere to different cultural paradigms and is opposed to alcohol consumption.

The geopolitical neighbourhood matrix cartogram (Fig. 8.9.4) shows three spatial clusters. Countries of the Euro-Atlantic alliance form a cluster with high values of per capita alcohol consumption, which is logically determined by the uniform cultural paradigms of the European and North American continents. Interestingly, the countries of Northern Europe also became part of the high-value cluster under the geopolitical matrix.

Global place	Country	Indicator (liters)
1 (1–10)	Mauritania, Yemen, Libya, Pakistan, Afghanistan, Kuwait, Bangladesh, Sudan, Iran, Somalia	0
2 (11–16)	Niger, Egypt, Bhutan, Indonesia, Syria, Saudi Arabia	0.1
3 (17–18)	Iraq, Comoro Islands	0.2
Median (94–95)	Burundi, Zambia	4
Mean (104–106)	(Philippines, Albania, Botswana)	4.784 (4.8)
185	Czech Republic	12.9
186	Estonia	13.3
187	Seychelles	20.2

Accordingly, the low-value cluster again includes countries with Islamic traditions. In this case, however, countries that did not make the cluster are ASEAN+3 member states, including Indonesia, i.e., countries with the highest percentage of Muslims, which likely means that the spatial autocorrelation cartogram of per capita alcohol consumption for the geopolitical neighbourhood matrix somewhat differs from the real distribution of values of the indicator under consideration.

Australia and New Zealand form a high-low cluster, which is also because of the European mindset of the majority of their people, while their neighbours have Muslim traditions.

Therefore, we may state that the use of the geopolitical neighbourhood matrix for analysing the spatial autocorrelation of alcohol consumption makes it possible, on the one hand, to cover countries that have weak geometric connections yet form a common cultural and historical space, while, on the other hand, this matrix fails, without grounds, to include those countries that meet the required values in its clusters, even though the geometric matrix does extend to them.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Alcohol consumption” parameter (Fig. 8.9.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. Similarly, test results show, on the one hand, a significant concentration of neighbouring states with similar (high) alcohol consumption in Europe, and, on the other hand, a large number of Middle Eastern countries with the lowest indicator values. At the same time, the test revealed a previously unidentified cluster of similar and relatively high values among Latin American countries that have a mostly Christian population.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Highly wealthy population	0.039	0.014	-0.22	1.241
2	Economic inequality	0.032	0.028	-0.181	1.024
3	Economic diversity	0.125	0	-0.322	0.829
4	Population growth	0.198	0	-0.405	0.828
5	Female population	0.083	0	0.257	0.796
6	Ethnic fractionalization	0.059	0.002	-0.211	0.755
7	Women in politics	0.109	0	0.283	0.735
8	Inbound tourism	0.079	0	0.24	0.729
9	IMF voting power	0.042	0.005	0.174	0.721
10	Number of doctors	0.272	0	0.438	0.705

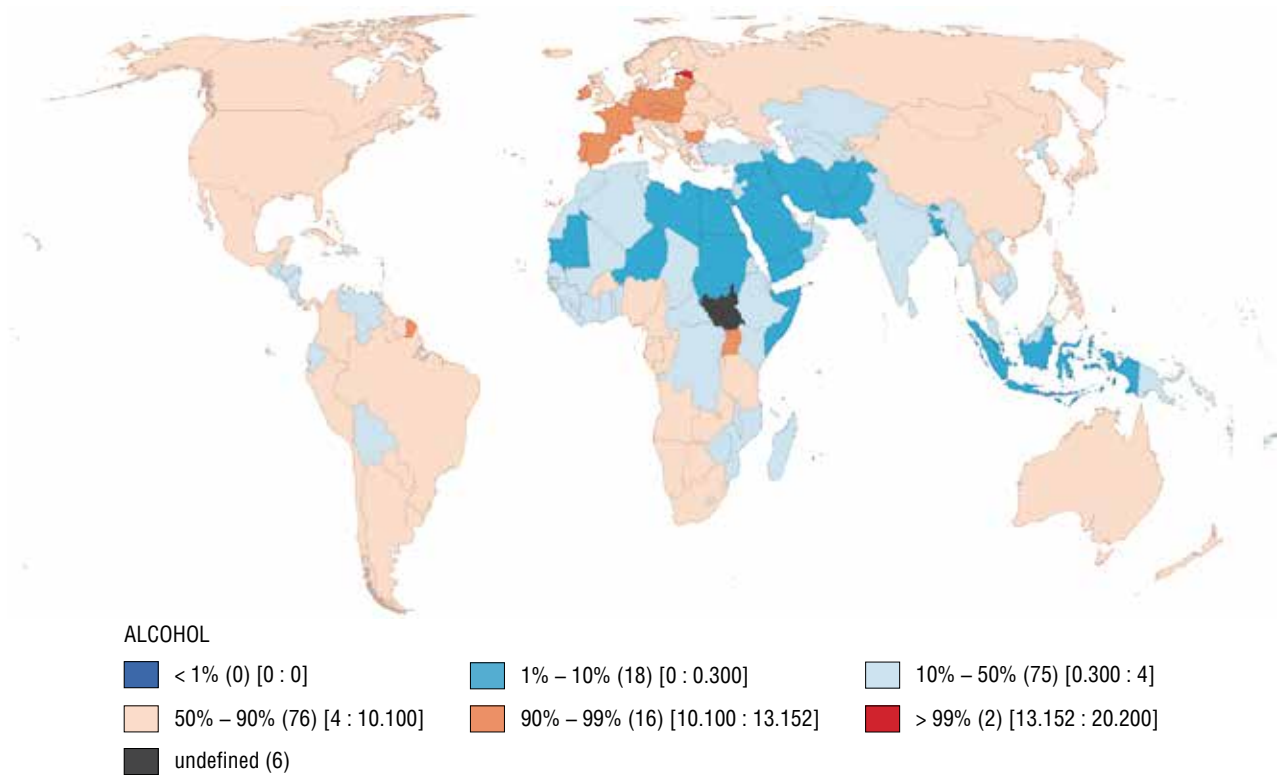


Fig. 8.9.1. Percentile cartogram for the “Alcohol consumption” indicator

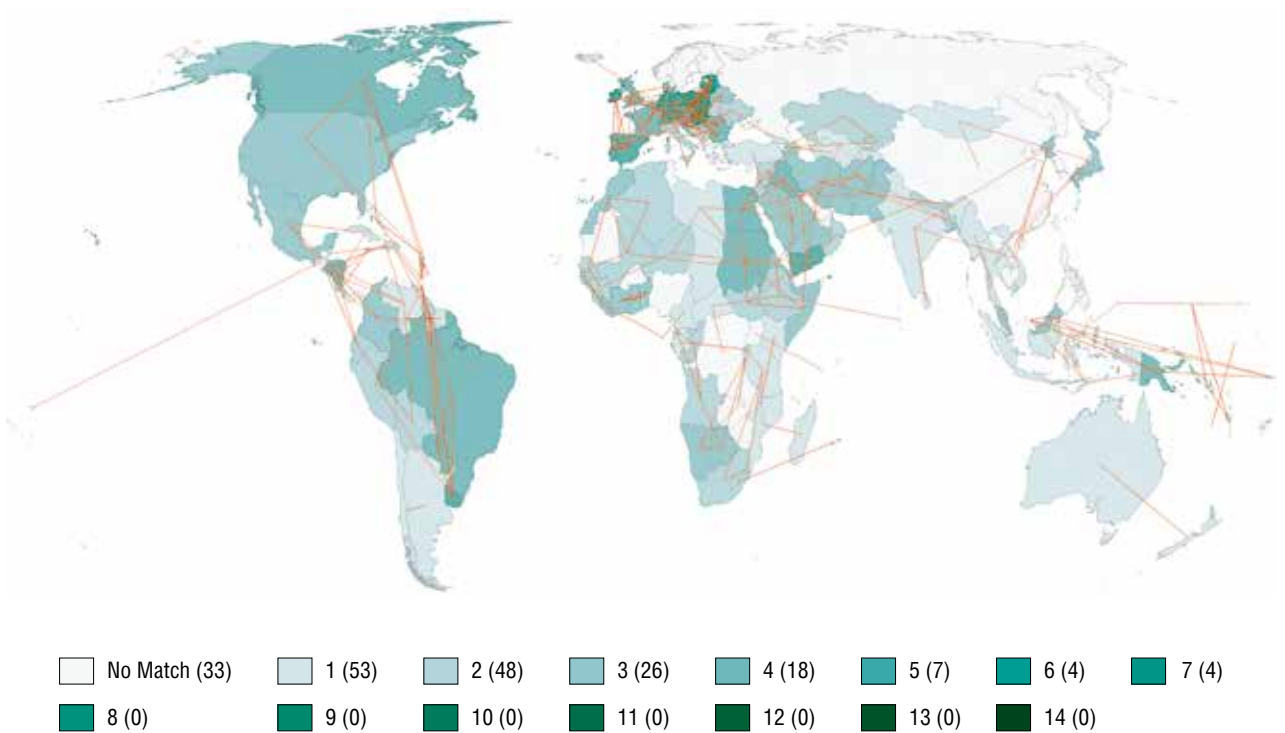


Fig. 8.9.2. Likelihood-ratio test for the “Alcohol consumption” parameter

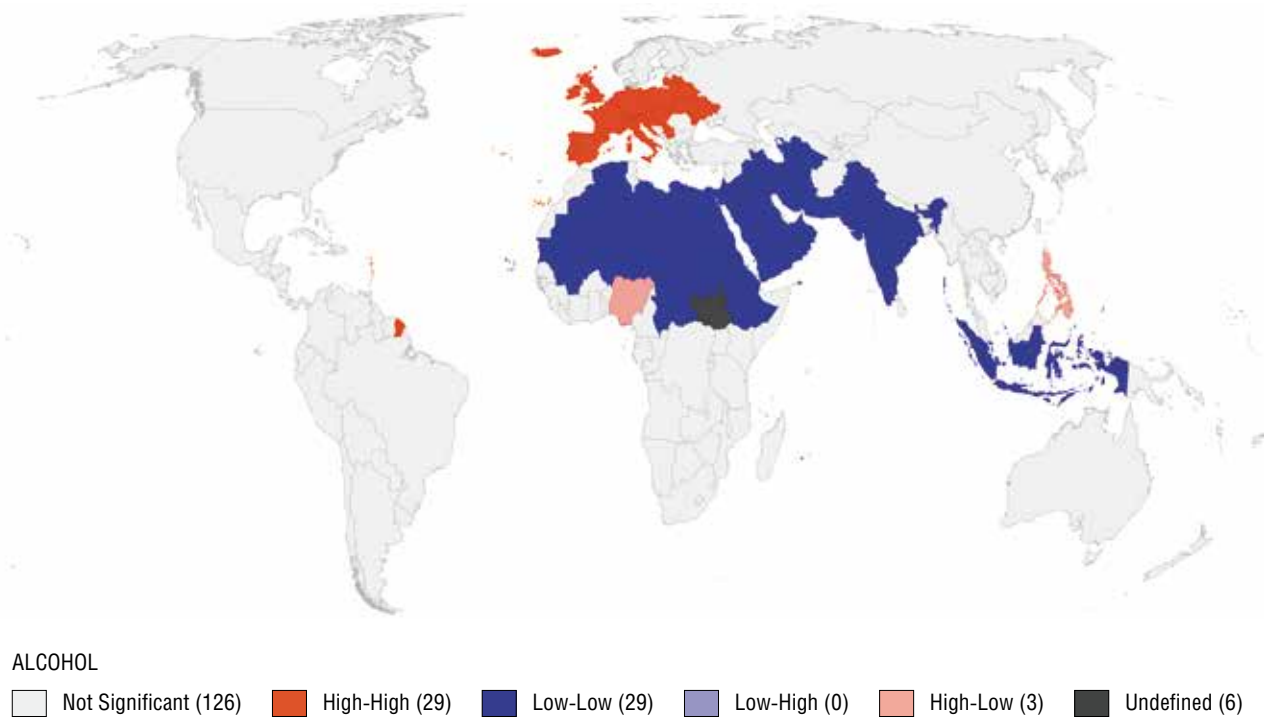


Fig. 8.9.3. “Alcohol consumption” spatial autocorrelation cartogram for the geometric neighbourhood matrix

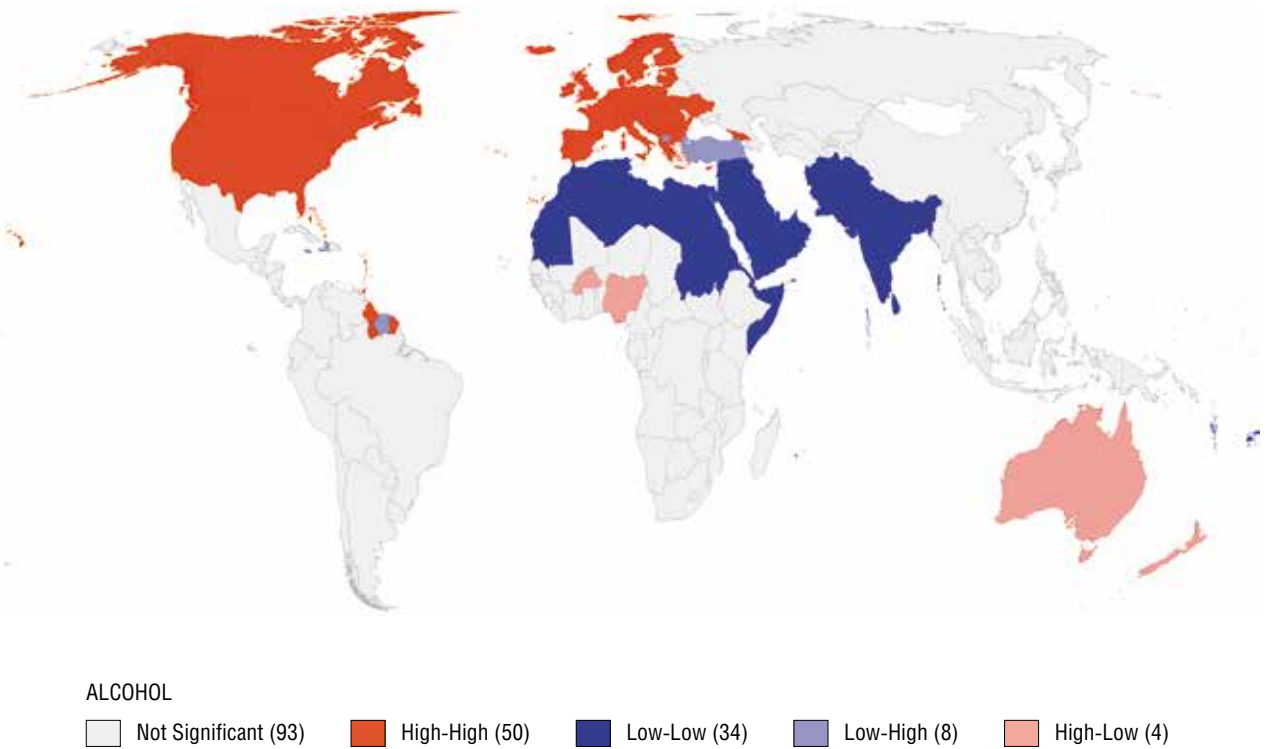


Fig. 8.9.4. “Alcohol consumption” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.10. Suicide rate

The “Suicide rate per 100,000 population” indicator measures success in achieving UN SDG 3.4: to reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promoting mental health and wellbeing.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.417	0.000	0.076	0.004
Geary's C	0.633	0.000	0.919	0.004

The percentile cartogram (Fig. 8.10.1) shows that countries with the highest indicator values are concentrated in the Northern hemisphere. High values are also typical for the most developed countries of the Southern hemisphere. Conversely, states with low suicide rates are mostly located in warmer climates. This cartogram does to a degree suggest that the world is somewhat split into North and South.

We should note that post-Soviet states — countries with short daylight hours — demonstrate high suicide rates, while the lowest rates are typical for countries with favourable climates and cultures that sharply condemn suicide.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 8.10.3) shows two clusters: one cluster with a high suicide rate per 100,000 population, and one cluster with low rates. High-value cluster spans post-Soviet states and East Asian states. These pessimistic statistics stem, first, from the continuing economic transition, which comes with challenges for the population of the former USSR in terms of living standards, social wellbeing, and cultural self-awareness, and, second, from the desire for maximum labour productivity that is typical for Asian cultures and naturally entails a tremendous workload that people are frequently unable to handle.

The low-value cluster is located in the Muslim states of West Asia, which is due, first, to the categorical rejection of suicide in Islam and, second, to the relatively high quality of life of the people of these countries.

Global place	Country	Indicator (incidence)
1	Antigua and Barbuda	0.5
2	Barbados	0.8
3	Grenada	1.7
Median (111–112)	(Mauritius, Myanmar)	7.75 (7.8)
Mean (125)	(Argentina)	9.18 (9.19)
164	Guyana	29.2
165	Russia	31
166	Lithuania	31.9

The geopolitical neighbourhood matrix cartogram (Fig. 8.10.4) shows four spatial clusters. The Euro-Atlantic cluster (with the exception of Italy, Spain, Germany, the UK, Turkey and the Balkan countries, which form the third, “low-high” cluster) has high suicide rates per 100,000 population. This data may be interpreted as a byproduct of European and North American cultures, which are characterized by individualism and the desire for maximum profit and constant career progress. This frequently leads to depression and, in extreme cases, suicide.

The second, low-value cluster is formed by member states of the Cooperation Council for the Arab States of the Gulf and the Arab League. These countries are predominantly Muslim, which is categorically opposed to suicide. They also have a relatively high quality of life thanks to oil production revenues.

The third, low-high, cluster shows that the Balkan states, Italy, Spain and Turkey have low suicide rates, which sets them apart from their neighbours. One reason for this may be cultural — the populations of these countries are not career-minded, and they place a high value on spending their leisure among their extended families, which helps reduce emotional stress.

The fourth, high-low, cluster includes the CARICOM countries. This group of countries demonstrates high suicide rates per 100,000 population, while their neighbours have low rates. This may be due to their relatively low quality of life (low GDP per capita, unemployment, underdeveloped infrastructure).

Therefore, compared with the geometric neighbourhood matrix, the geopolitical neighbourhood matrix has the advantage in terms of reflecting the cultural specifics of states considered through the lens of suicide rate per 100,000 population.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Suicide mortality” parameter (Fig. 8.10.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The test results largely confirm the claims above as, first, they demonstrate a high concentration of connections in Europe, where geographically proximate states have both high and relatively low suicide rates per 100,000 population. Second, the test illustrates the geographical proximity of many countries of the Maghreb and the Middle East that have low indicator values. Third, the test also confirms the existence of a cluster of similar (low) values in the countries of the Caribbean Community. At the same time, we should note that the rest results identify a new cluster of similar (low) values in Southeast Asia.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Maternal mortality to fatalities ratio	0.024	0.045	−0.181	1.365
2	Conservation areas	0.051	0.004	0.263	1.356
3	Life expectancy	0.025	0.042	0.178	1.267
4	Transfers of FDI revenues abroad	0.042	0.017	0.23	1.26
5	Infant mortality rate	0.047	0.005	−0.227	1.096
6	Linguistic diversity coefficient	0.037	0.013	−0.197	1.049
7	Forests (% of the area size)	0.027	0.036	0.162	0.972
8	Female population (%)	0.075	0	0.257	0.881
9	Passport power	0.119	0	0.318	0.85
10	Population growth	0.168	0	−0.372	0.824

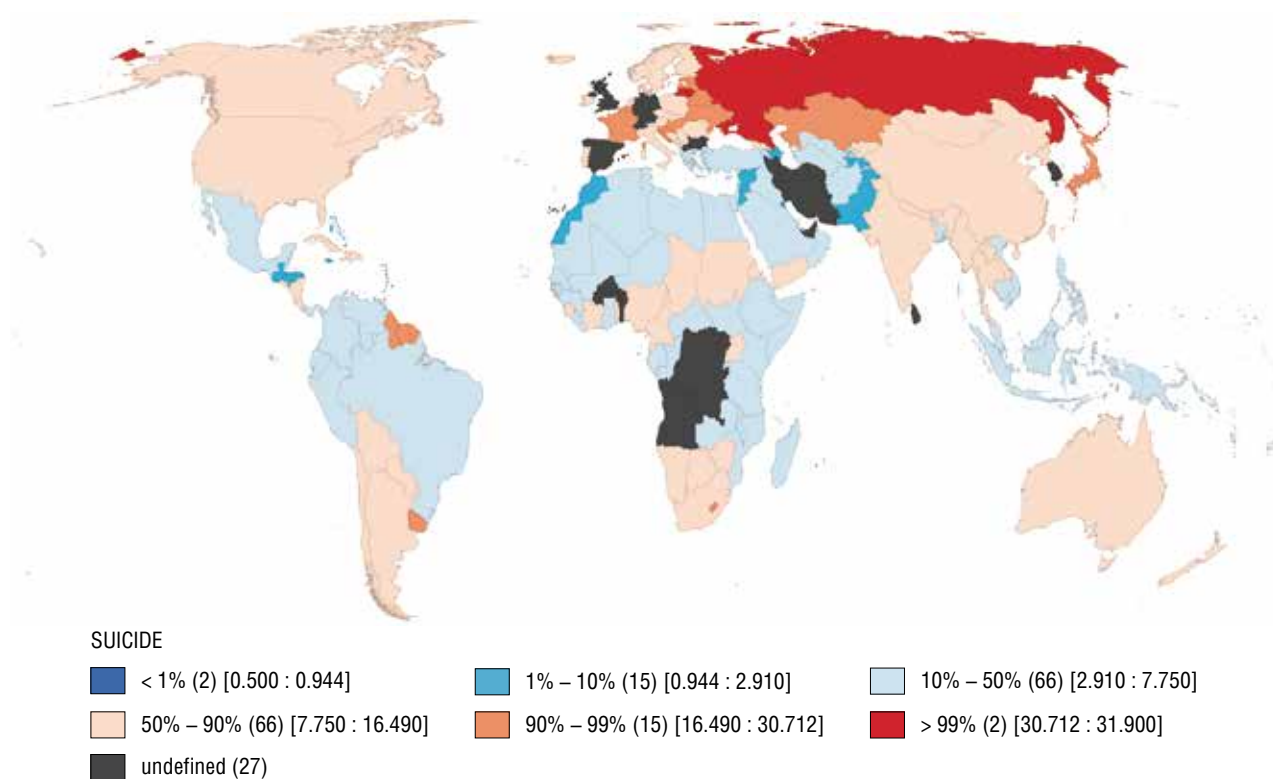


Fig. 8.10.1. Percentile cartogram for the “Suicide rate” indicator

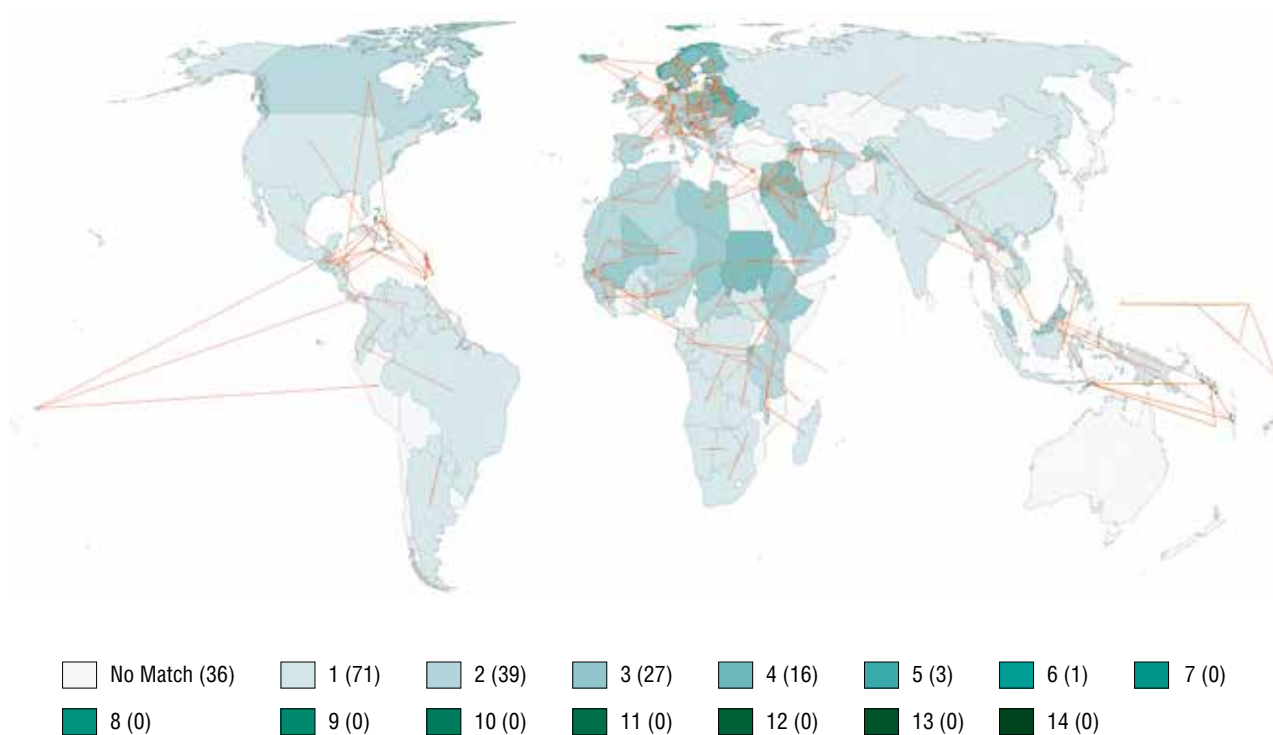


Fig. 8.10.2. Likelihood-ratio test for the “Suicide rate”

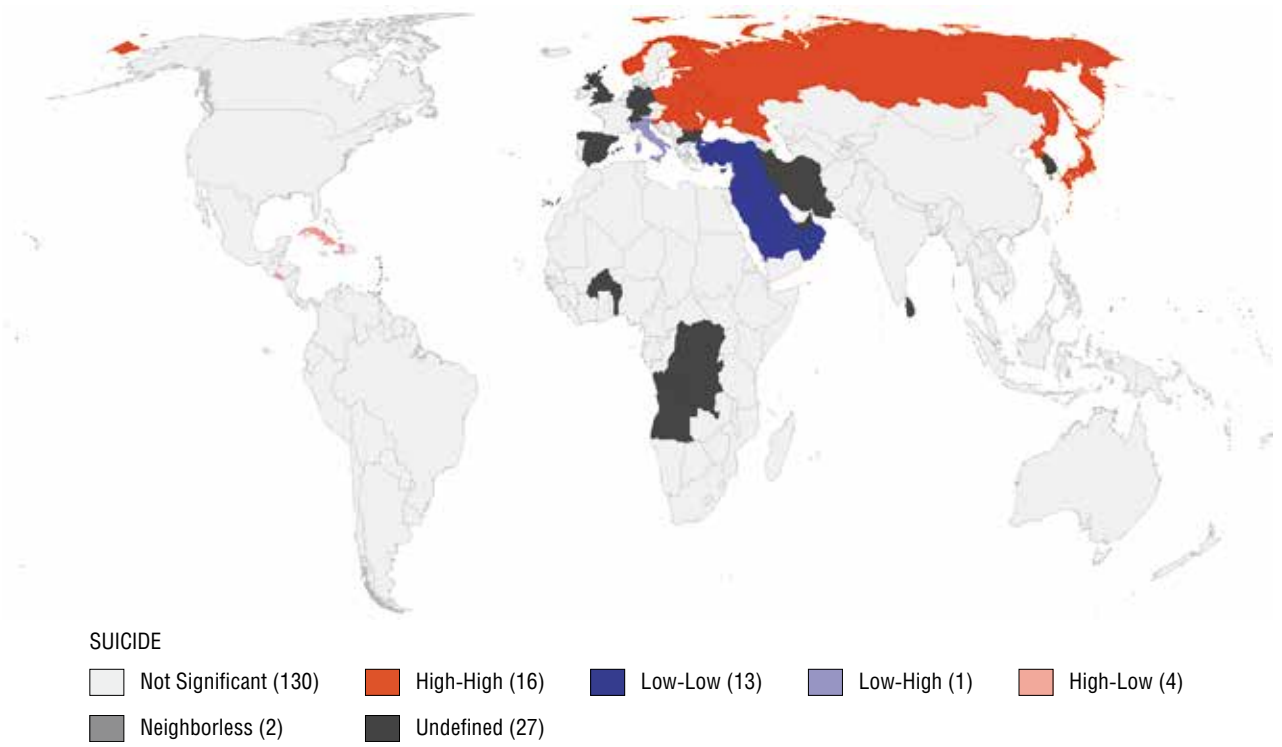


Fig. 8.10.3. “Suicide rate” spatial autocorrelation cartogram for the geometric neighbourhood matrix

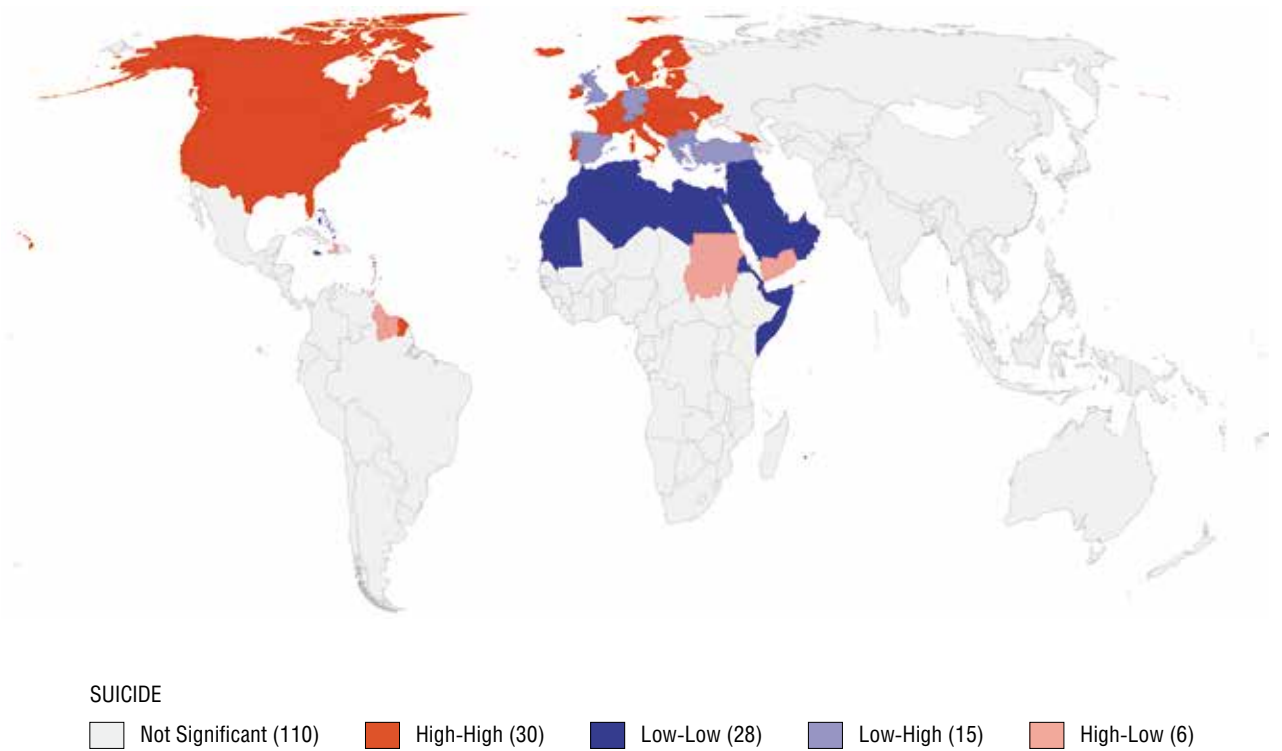


Fig. 8.10.4. “Suicide rate” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

8.11. Multifactor analysis of “Healthcare” section indicators

Logically, the next step in assessing country healthcare systems is to analyse the entire group of respective indicators.

In order to conduct two- and three-factor analysis of worldwide spatial distribution of healthcare-related phenomena, we used the geographic average ellipse method: among the “Healthcare” section indicators, major geographic average divergences can be observed for pharmaceutical exports, per capita healthcare spending, and HIV incidence per 100,000 population.

The geographic average of HIV incidence per 100,000 population is significantly skewed southward compared to the same point for the two other indicators. This is presumably caused by the fact that largest proportion of HIV-infected people lives in sub-Saharan Africa. Because the “HIV incidence per 100,000 population” indicator has high spatial concentration, its geographic average ellipse has the least elongated shape.

Compared to HIV incidence per 100,000 population, geographic averages for pharmaceutical exports and per capita healthcare spending are rather skewed northward towards the Mediterranean, because, in the first instance, pharmaceutical industries and pharmaceutical exports are concentrated in the European and North African countries, which demonstrate the highest pharmaceutical exports to GDP ratios, and, in the second instance, because developed European, Middle Eastern, some Asian, and certainly North American economies have high healthcare spending. We should stress that the geographic average for pharmaceutical exports is somewhat more northerly than the similar point for healthcare spending, since the European cluster is the leader in the pharmaceutical industry, while the ellipse for healthcare spending is significantly stretched along the West–East line because of North America’s leading position for this indicator and because of major healthcare spending in developed East Asian states.

When geographic average ellipses are considered by geopolitical group, we observe major divergences for HIV incidence and ART coverage. The geographic average gap visible in North Africa, on the Indian subcontinent and around Australia indicates intra-bloc inequality. HIV ellipses are skewed towards more afflicted states with fewer successes in countering the epidemic (towards Sudan, Pakistan and Papua New Guinea). At the same time, some neighbours in geopolitical blocs have better situations in terms of both preventing the spread of the disease and effectively distributing ART medicines. On the other hand, geographic average ellipses almost entirely coincide for sub-Saharan Africa, Latin America and the Caribbean blocs. This indicates equality within the regions of the global South. The Euro-Atlantic ellipse is not valid, since the difference stems from lack of ART coverage statistics for North America.

We have calculated and mapped the multifactor local Geary’s C for both spatial neighbourhood weights matrices in order to conduct a cumulative analysis of spatial autocorrelation of “Healthcare” section indicators. The cartograms for Geary’s C show groups of neighbouring states that are most similar and most dissimilar to their neighbours in the ten indicators of the “Healthcare” section (Fig. 8.11.1 and Fig. 8.11.2).

Four clusters are identified: South America, Africa, North Eurasia, and South Asia. These clusters demonstrate significant spatial correlation for the ten indicators in the “Healthcare” section. The lack of spatial correlation in North America is noteworthy (high values for the United States and Canada do not correlate with Mexico’s mean values). There is also no significant spatial correlation in East Asia and Oceania: these regions demonstrate major internal disproportions.

The geopolitical neighbourhood matrix changes the picture: the Euro-Atlantic forms a single spatial cluster, although it does have exceptions: the Balkan states, Eastern Europe and Turkey stand out from the overall picture, forming a mini-cluster with negative spatial autocorrelation. This indicates profound intra-European disproportions in healthcare development and reflects the problems inherent in the European Union’s eastward expansion. Even though the European Union’s new Eastern European members (Poland and the Baltic states) do not exhibit negative correlation, they still “drop out” from the overall cluster, demonstrating the worst healthcare development indicators. Additionally, Central America forms a single

spatial cluster that was not observed on the previous cartogram. On the other hand, several of the poorest African countries and some Latin American countries drop out from clusters.

Since the above-described spatial autocorrelation methods (global and local, one-, two-, and multifactor autocorrelation) are largely focused on statistical similarities between neighbouring phenomena, at the next stage, we use a method that allows us to identify and interpret geographic exceptions where a given country shows maximum dissimilarity to its neighbours. The cluster analysis cartogram non-adjusted for geographic proximity shows significant clustering on continents into groups of neighbouring states with similar median values of their healthcare indicators (Fig. 8.11.3).

The African continent is split into the largest number of clusters, with each including at least three countries, which clearly evidences spatial regularities in the development of healthcare systems in African countries. Six clusters can be identified: the economically successful countries of the Maghreb; most of the agrarian countries of the Sahel; the distressed countries of the Horn of Africa, which form a single cluster with weak economies of Central Africa; countries that produce extractable resources — members of the Southern African Customs Union; and countries of the Gulf of Guinea that are split into two mini-clusters — less developed economies in the west and more industrially developed countries in the east, including Nigeria and Cameroon.

The United States and Canada, similar in terms of healthcare development, naturally form a single cluster. Further south is a monolithic cluster of Latin American states with similar economic, political and social indicators. However, Chile and Argentina stand out in separate clusters as the continent's most developed economies. Conversely, Eurasia looks far less consolidated since clustering there is observed primarily in Europe and accords with its regionalization.

The second cartogram, where the geographic factor is assigned the same value as the sum of all other indicators, reveals far clearer clusters, but some countries stand out from their groups (Fig. 8.11.4). For instance, the clusters in the east and south of Eurasia are radically transformed: when statistics and geography are combined, individual differences between national healthcare systems in Asia fade into the background because of their general dissimilarity to European and North American healthcare systems. Additionally, the Southeast Asian case deserves special mention, as it forms a monolithic cluster of countries. We could also point out its unique healthcare system, which is defined by high population density and special political regimes that determine the provision of healthcare services to the population.

Exceptions that emerged on the European continent also deserve a mention: notably, with greater significance assigned to geographic proximity, Eastern European countries form a single cluster of similar values for healthcare indicators; Central and Northern European countries also formed a common cluster due to their economic features that largely define their healthcare sectors.

Subsequently, in order to downscale the group of “Healthcare” indicators under consideration, the research team used multidimensional scaling that represents differences between objects as a two-dimensional dispersion chart. The scatter plot representing country values following multidimensional scaling of economic indicators clearly shows the division into developing and developed countries: all African states with the exception of Mauritius are located in the left-hand part of the chart (Fig. 8.11.5). The largest developing states, India and China, tend towards the crossing of axes. Switzerland, which is further apart from the others, stands out as a better case. Russia is in the right-hand part of the chart, its nearest neighbours in healthcare development values are two Baltic states (Estonia and Latvia), Italy, Cuba, Australia and New Zealand.



Fig. 8.11.1. "Healthcare" section spatial autocorrelation cartogram for the geometric neighbourhood matrix

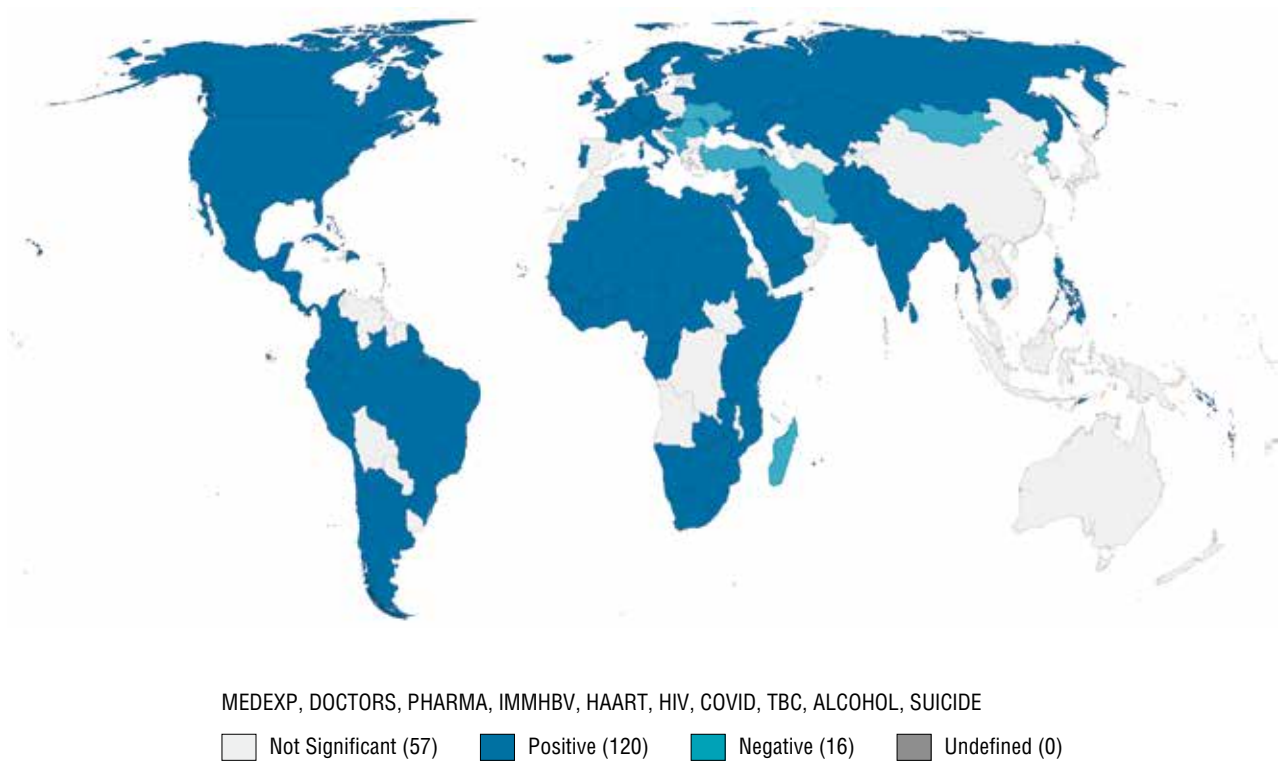


Fig. 8.11.2. "Healthcare" section spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

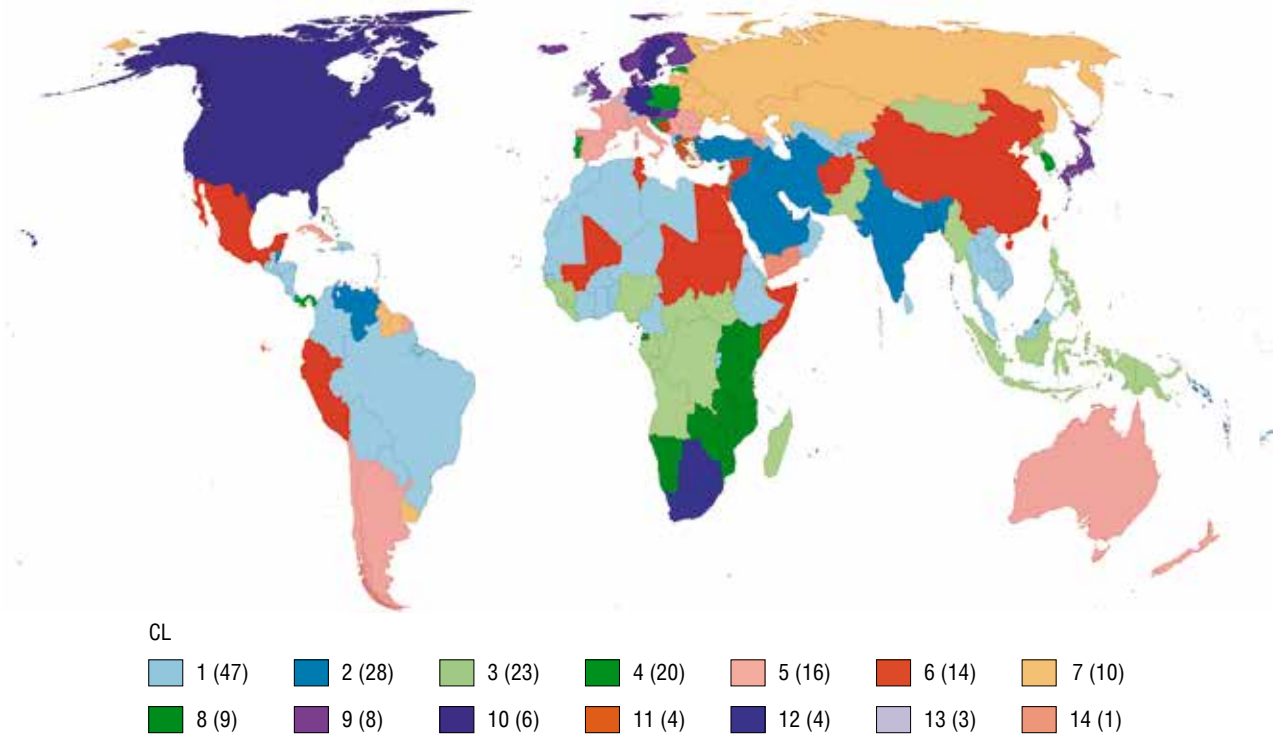


Fig. 8.11.3. Statistical clusters cartogram for the “Healthcare” section indicators

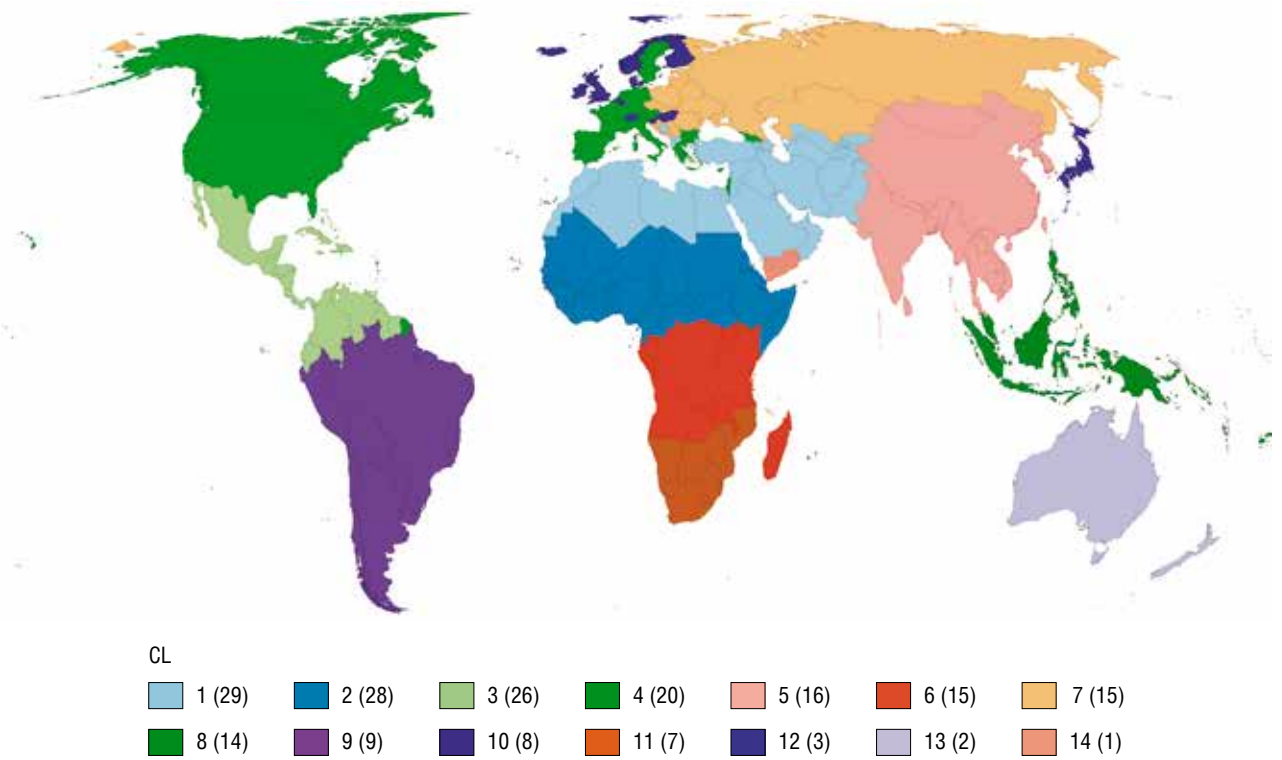
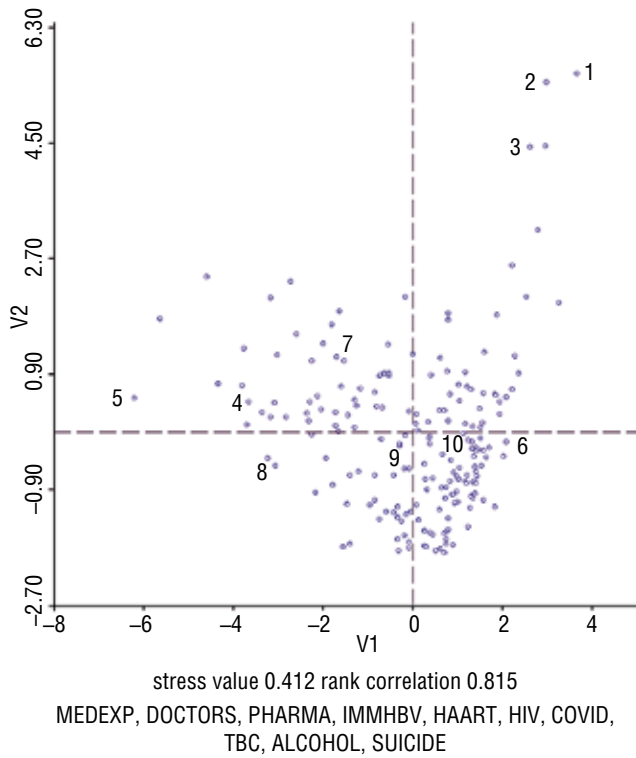


Fig. 8.11.4. Statistical clusters cartogram for the “Healthcare” section indicators adjusted for geographic proximity



1	Lesotho
2	Eswatini (Swaziland)
3	South Africa
4	USA
5	Switzerland
6	DRC
7	Russia
8	Great Britain
9	China
10	India

Fig. 8.11.5. Multidimensional scaling chart for the "Healthcare" section indicators

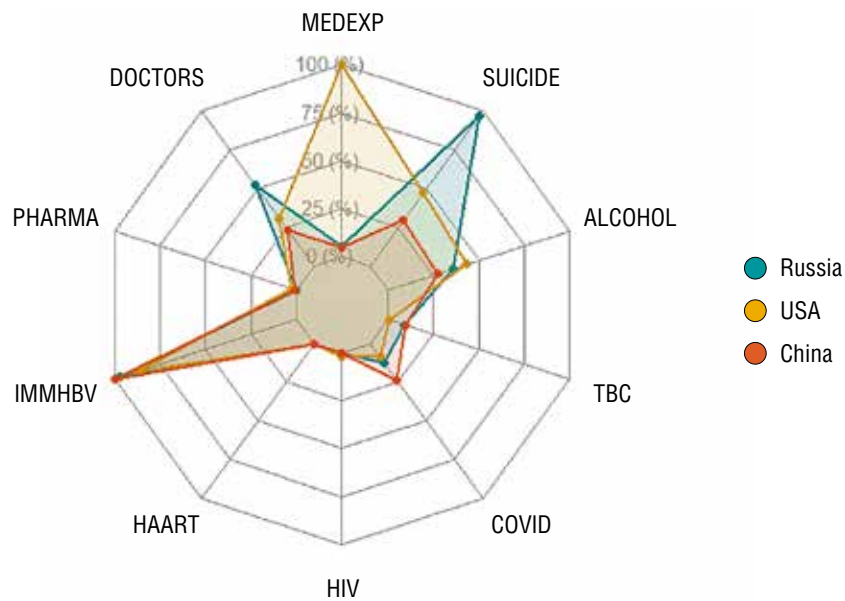


Fig. 8.11.6. Radar chart for the "Healthcare" section indicators

8.12. Spatial factor and “Healthcare” section indicators

While working on the “Healthcare” section, the research team strove to provide a multifaceted assessment of various aspects of the healthcare sector across the world while restricting themselves to ten indicators only. The indicators for the spatial analysis were selected within three categories only: healthcare system, population health, and social wellbeing. The research focused on both traditional indicators of a state’s healthcare system (such as healthcare spending and HIV incidence), and a radically new “COVID-19 mortality” indicator.

Using spatial econometrics methods, the research team calculated Moran’s I for all ten healthcare indicators under two spatial matrices of neighbourhood weights, the geometric matrix and the geopolitical matrix. In nine cases, the neighbourhood effect proved to be more significant in the absolute (“geometric”) space, where neighbourhood is determined by state borders and physical proximity of country capitals, than in the relative geopolitical space, where neighbourhood is determined by the degree of involvement in regional political and economic integration alliances. Moreover, we can claim that the only case where the geopolitical matrix yielded weightier results cannot be valid since the P-value obtained for the indicator is insignificant.

It is necessary therefore to point out that HIV incidence has proved to be the most significant indicator in the geometric spatial weights matrix. It is the leader among all indicators considered in the Atlas (Moran’s I — 0.834), while the most significant indicator for the geopolitical matrix is percentage of children under one vaccinated against hepatitis B (Moran’s I — 0.748). Accordingly, the values for these indicators demonstrate greater neighbourhood effect than the other indicators in the group. These results are logical, since in the first case, the spread of a viral disease is geographically determined, while in the second case, the hepatitis B vaccination is a global phenomenon, but its scale is mediated by culturally determined parameters.

As for the results of a comparative analysis of healthcare indicators and all the other 90 indicators in the Atlas, the strongest spatial effect is most frequently observed in connection with indicators from the “Equality” group. Of the 100 indicator pairings represented in the tables as demonstrating the greatest spatial effect, in 23 cases a high spatial effect index is recorded for an indicator from the “Healthcare” section and an indicator from the “Equality” section.

“Population growth” from the “Demographics” indicator group is the indicator that most frequently demonstrated high spatial effect index values, appearing in the top 10 for seven healthcare indicators. It is, however, important to stress that in most indicator pairings, the two-factor Moran’s I has a negative value. This invites the conclusion that high rates of population growth are rather typical for countries with underdeveloped healthcare systems, which largely agrees with the realities of many neighbouring developing countries.

Our analysis also yielded the following findings: in 22 cases out of 100, the spatial effect proved to be greater than a mere correlation; “Pharmaceutical exports” and “Debt inward FDI stock” is the indicator pairing with the highest spatial effect index, which is likely due to coinciding clusters of developed financial markets and a developed pharmaceutical industry.

In conclusion, it should be said that further study of spatial connections between healthcare indicators and other human development indicators carries large-scale heuristic potential, especially when spatial analysis methods are applied to sub-national units. This will potentially make it possible to set benchmarks for harmoniously developing healthcare sectors across the world and, accordingly, to ensure a high quality of life.

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9 *Culture*

Cultural solidarity

Ethnic fractionalization

Ethnic minorities

Linguistic diversity

Religious diversity

Cultural exports

Bioethical freedom

Film industry

Literacy

Number of libraries

FOR the “Culture” section, the research team selected several indicators that we believe most fully reflect the cultural diversity of the modern world and are best suited for mapping. We understand “culture” in the broadest sense possible: as a non-material realm of human activities that has both been created by humanity and which determines human existence. The indicators included in this section may be notionally divided into the following conceptualization categories (Faulkner et al. 2006):

1. Culture as a characteristic of a person that reflects their belonging to a certain community.
2. A system of symbols used for communication in a society including language and related specific cultural features.
3. Manifestation of culture as a product of human activities.
4. Culture understood as a level of education.
5. The moral aspect and related moral dilemmas.

Naturally, culture in a broad sense is reflected by the so-called ethnic indicators, since it is ethnicity that largely determines the cultural features of a social group or individual, influencing both the cognitive and emotional aspects of human identity. One of the most widely used indicators in scientific research is the ethnic fractionalization index (also called ethnic diversity index or ethnic dissociation index) [Alesina et al. 2003; Fearon 2003]. This indicator is indeed among the most representative: it measures the likelihood of two randomly selected individuals within a country/region belonging to the same ethnic group. Clearly, this index will differ greatly between those societies that are relatively homogeneous ethnically (such as Armenia or Japan) and in polyethnic, multi-component polities (the United States, Canada, India). The indicator is calculated by many organizations and individual researchers. This section uses the most authoritative and comprehensive database compiled by the Migration Policy Centre at the European University Institute and presented in the Harvard Dataverse [Drazanova 2020].

The indicator measuring the largest ethnic minority as percentage of the population will help draw additional conclusions and gain a more complete picture. In addition to the overall fragmentedness, it is important to understand the percentage of minorities belonging to a single ethnic group. This indicator is a component of the large “Ethnic Power Relations” dataset that is compiled and regularly updated by the

Swiss Federal Institute of Technology in Zurich [Vogt et al. 2015]. This dataset is widely used for assessing the ethnopolitical situation in countries and regions [Birbir et al. 2015; Rügger 2018].

Finally, the “Cultural solidarity” indicator (Estes 2004) places these indicators within a broader context of ethnic, denominational and linguistic diversity without going into too many details. This is a component of the “Weighted index of social progress” proposed by Richard Estes and calculated by the Management Institute for Quality-of-Life Studies. Although this index is not quite as popular as the ones mentioned before, it has been actively used in the last decades in studies of human development and potential [Osberg 2001; Accardo 2020].

The next category in this section is the religious affiliation of various population groups, or, rather, the indicator of their diversification under this criterion: the religious diversity index. This indicator assesses the degree of consolidation in society based on information on the percentages of the seven basic religious groups and the religiously unaffiliated population. Dominant traditional concepts and political culture and, conversely, the need to constantly find a balance between communities with various worldviews, may be based on a society’s denominational structure, and that will determine the ways in which the path of human development manifest themselves. The linguistic diversity coefficient has similar features. It measures the likelihood of two randomly selected persons being native speakers of two different languages. Language is the basic instrument of communication between speakers of that language and within state institutions. Therefore, a state’s linguistic structure largely determines both the daily life of individuals and the features of political management [Ginsburgh 2014].

Certainly, both material and non-material culture is an integral part of the economic sector and, consequently, it is necessary to consider this part of the economic structure of the modern world, which, additionally, is becoming increasingly important as the services market develops [Du Gay and Pryke 2002]. The overall economic and cultural situation in the world is represented in this section by the share of exports of cultural goods in a country’s total exports, including all cultural products valued in monetary terms, from works of art to computer software. The second indicator, the number of feature films and documentaries released by a country in a year, is not typical for large-scale research projects, but a developed film industry attests to a whole range of features: the standard of living of the population that actively consumes entertainment industry products and can thus access this sector; the number of jobs in film production, reflecting labour distribution in a given economy; and the “soft power” policy that a country may deliberately pursue by broadcasting its cultural influence through film industry products.

We should also note that specific cultural features may manifest as moral compasses for society and, consequently, may lead to a specific moral choice in controversial matters pertaining, among other things, to human existence. To reflect the realities of this area, we have selected the bioethical moral freedom index, which indicates how free individuals are in their decision-making within state-established restrictions on the main questions that present a bioethical dilemma, such as abortions, euthanasia, etc.

Finally, two indicators in our research reflect the concept of culture as an aspect of human progress and education as such. The first indicator is adult literacy, which measures the percentage of the population aged 15 and older that can read and write short simple sentences about everyday life. These are basic skills for gaining further command of human achievements and accumulated knowledge. At the same time, we have represented access to knowledge as such in the number of libraries of all types, including libraries at educational institutions. Even though academic literature, classics and fiction are being digitized today, digitized knowledge is still linked to a certain library or a network of libraries that provide access to digitized entities, and libraries themselves are being transformed into multifunctional venues, which means that the indicator remains relevant.

Thus, this section covers most phenomena that researchers today classify as “culture,” and each such phenomenon is directly related to human development issues.

9.1. Cultural solidarity

This indicator demonstrates the degree of ethnic, linguistic and denominational homogeneity of a country's population.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.410	0.000	0.225	0.000
Geary's C	0.575	0.000	0.771	0.000

Predictably, the cultural solidarity leaders are three virtually monoethnic, monodenominational and monolingualistic countries. The bottom positions are occupied by Nepal (which has approximately 70 languages/dialects and whose ethnic majority makes up less than half of the population), two polyethnic and polydenominational (in case of Tanzania) African states, and Canada (which is split between French-speaking and English-speaking communities).

The percentile cartogram (Fig. 9.1.1) shows that countries with the highest indicator values are concentrated in Europe, North and South America, and Australia. Clearly, the populations of both Americas are not monoethnic, yet the indicator remains high due to relative linguistic (English, Spanish, Portuguese) and denominational (various Christian denominations) homogeneity. Low values are characteristic for sub-Saharan African states and most Asian states. Countries in "high" percentile sections have high ethnic, linguistic and, in some instances, denominational heterogeneity.

The geometric neighbourhood matrix yields a greater spatial correlation (moderately positive correlation) than the geopolitical matrix (weak positive correlation), and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.1.3) shows only one low value cultural solidarity cluster that is made up of most Central African states and several countries

Global place	Country	Indicator
1	Armenia	21.4000
2	Tunisia	21.3000
3	Libya	20.7000
Median (81)	(Cuba)	11.2 (11.25)
Mean (83)	(Burundi)	10.7525 (10.8)
157–158	Tanzania, Canada	0.7000
159	Eritrea	0.5000
160	Nepal	0.1000

of the south due to the extraordinary ethnic and linguistic heterogeneity of the population structures of these countries.

On the other hand, the geopolitical neighbourhood matrix cartogram (Fig. 9.1.4) shows several spatial clusters. It presents a single high value cultural solidarity cluster among the countries of Europe and North America, with the significant exceptions of Estonia, Latvia (a large Russian-speaking minority in both countries keep them from having a high indicator value), North Macedonia (the Albanian minority), the polyethnic federations of Switzerland, Belgium, and Canada. Noteworthy outliers are Czech Republic and the Netherlands — countries that are not heterogeneous from the point of view of ethnic majority and language, but they are heterogeneous denominationally. Another standout cluster is a low-value cluster in West Africa. The exception here is the Gambia, which is hard to explain demographically: its ethnic and linguistic structure is highly heterogeneous, even though it is definitely dominated by a single religious denomination, Sunni Islam.

Therefore, the geopolitical neighbourhood matrix allows us to consider a larger number of clusters determined not only by “bloc” membership, but also by belonging to a particular cultural and civilizational area. Nevertheless, the important Central and Southern African cluster that is visible on the geometric matrix vanishes from the geopolitical cartogram: relevant states are now divided between the Economic Community of Central African States and the Southern African Customs Union. Therefore, the two cartograms logically supplement each other.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Cultural solidarity” parameter (Fig. 9.1.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The relevant cartogram clearly demonstrates largely the same clusters as shown on the percentile cartogram: a South American cluster, and several African and Asian clusters. Nevertheless, there are no significant clusters in Europe.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Institutional foundations of democracy	0.04	0.012	0.21	1.103
2	Bioethical freedom	0.031	0.036	0.183	1.08
3	GDP (PPP) per capita	0.057	0.003	0.235	0.969
4	Mobile subscribers	0.035	0.024	0.182	0.946
5	Publication activity	0.059	0.002	0.234	0.928
6	Corruption	0.046	0.007	0.204	0.905
7	Infant mortality	0.16	0.000	−0.379	0.898
8	Years at school	0.115	0.000	0.319	0.885
9	Internet users	0.132	0.000	0.33	0.825
10	Access to electricity	0.138	0.000	0.336	0.818

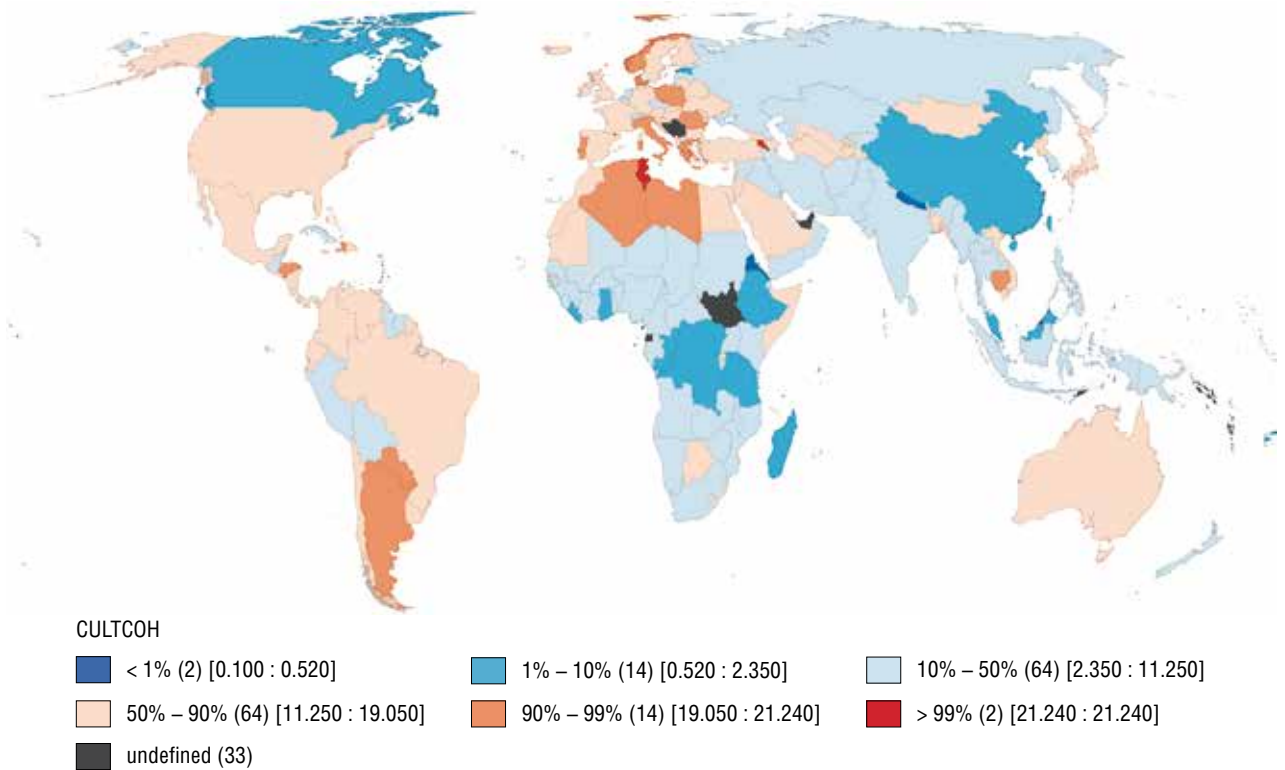


Fig. 9.1.1. Percentile cartogram for the “Cultural solidarity” indicator

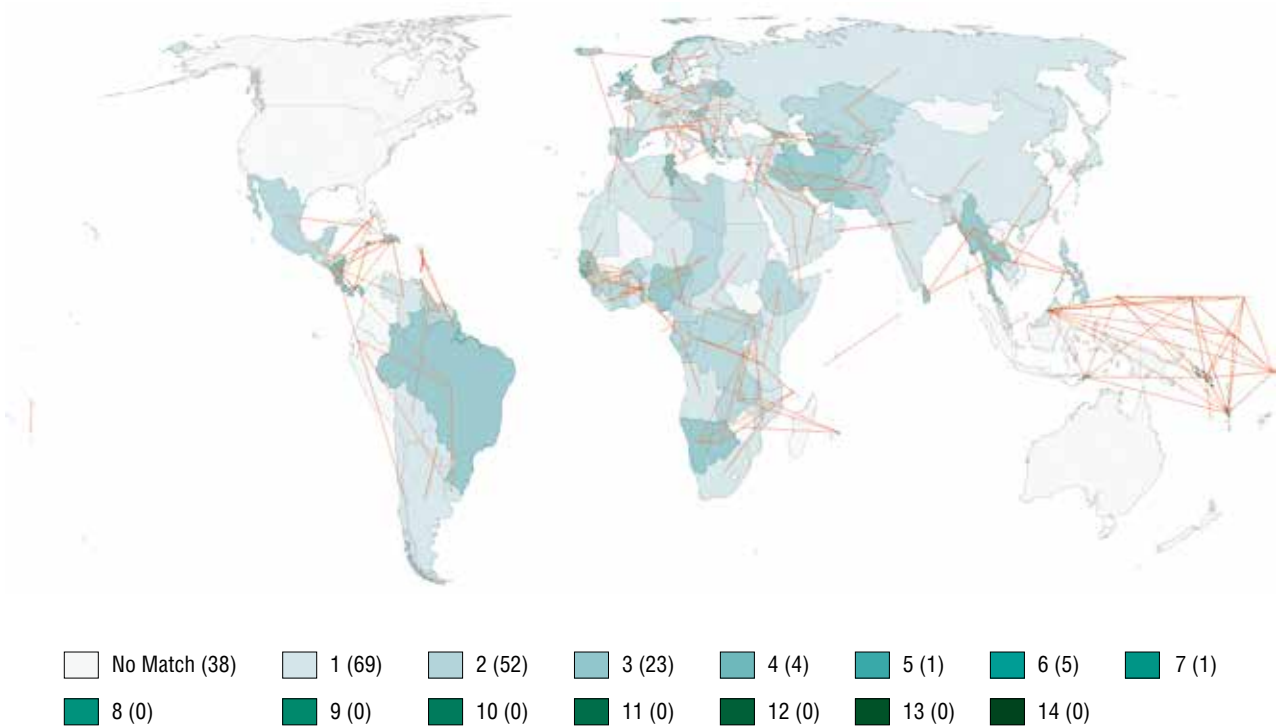


Fig. 9.1.2. Likelihood-ratio test for the “Cultural solidarity” parameter

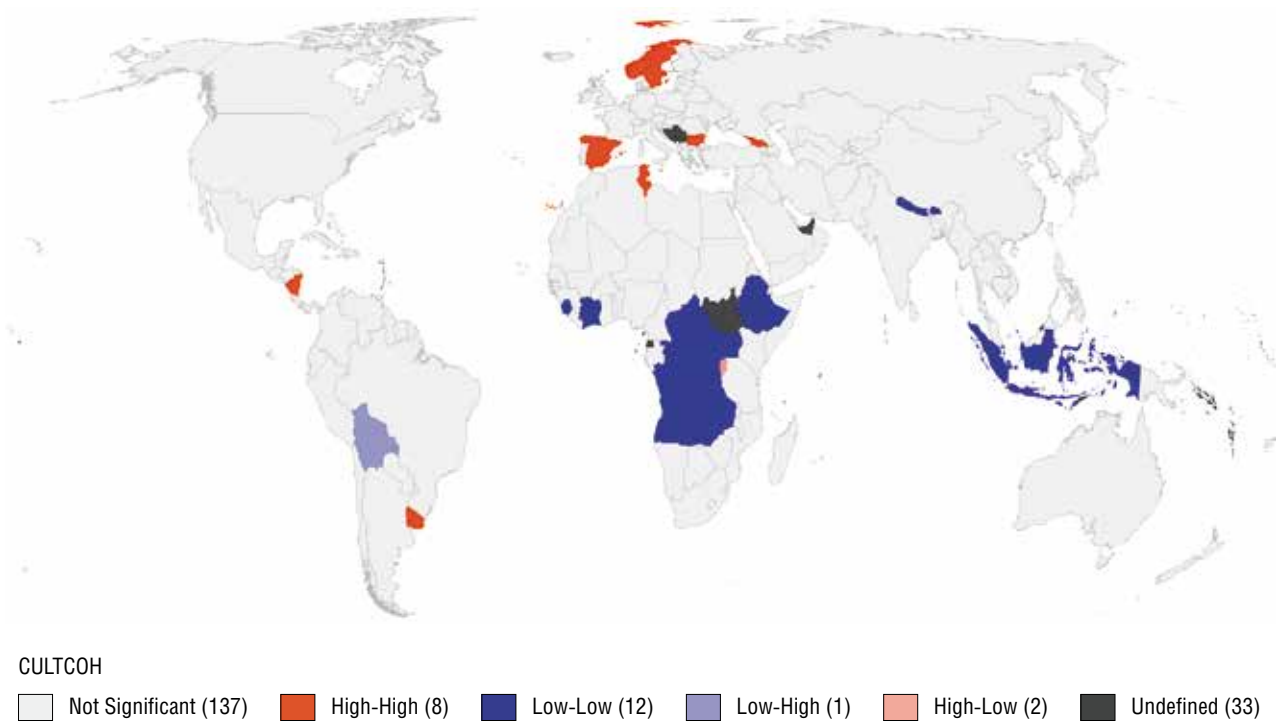


Fig. 9.1.3. “Cultural solidarity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

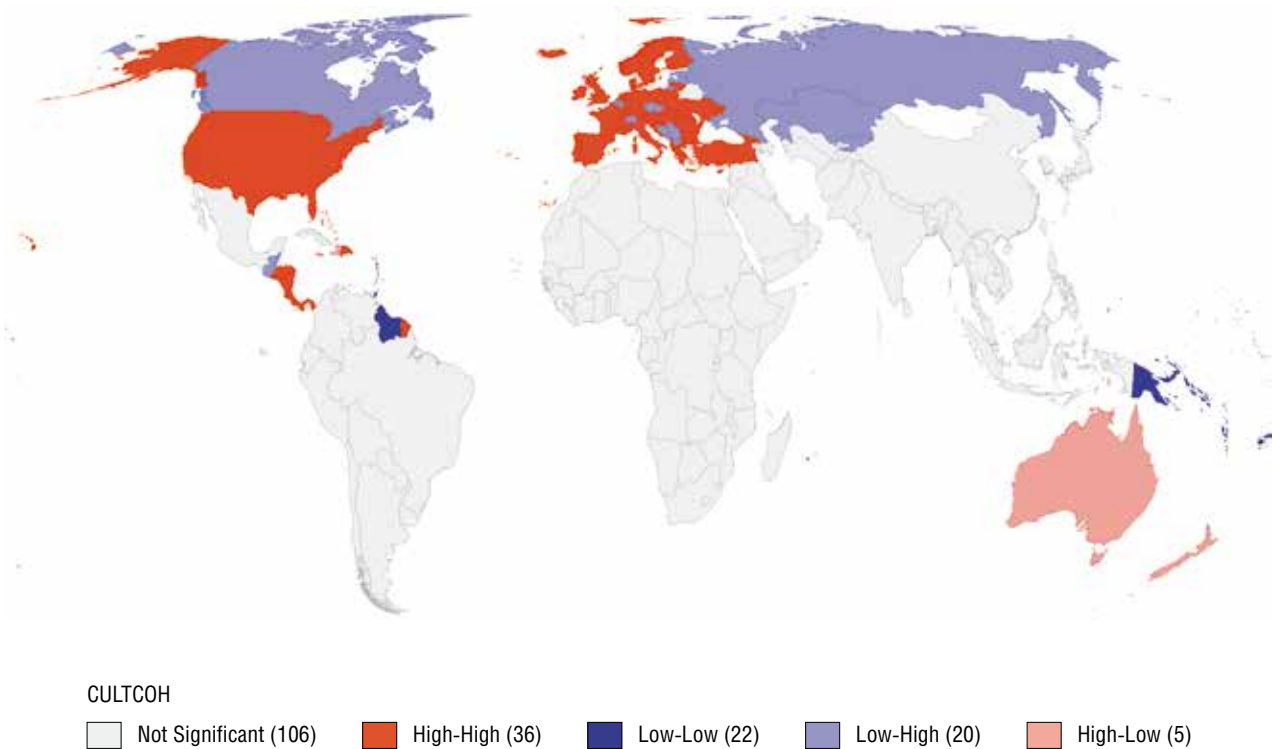


Fig. 9.1.4. “Cultural solidarity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.2. Ethnic fractionalization

This indicator measures the ethnic heterogeneity of a state.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.321	0.000	0.254	0.000
Geary's C	0.665	0.000	0.742	0.000

The ethnic fractionalization index is topped by three African states, which is explained by the fact that many African countries have a high degree of ethnic heterogeneity caused by arbitrarily drawn colonial borders. The rear is brought up by monoethnic East Asian countries, which is likely due to the societies in these countries being long (and, in the case of North Korea, still) closed off for migration of different ethnicities.

The percentile cartogram (Fig. 9.2.1) shows that countries with the highest indicator values are concentrated in sub-Saharan Africa, Southeast and Southwest Asia and North and South America, while the lowest values unite the countries of Europe, East Asia and North Africa. High values are due to heterogeneous ethnic structure and migratory nature of post-colonial settlement (for American states). Low ethnic fractionalization values are due to the monoethnic (or nearly monoethnic) population structure in relevant states.

The geometric neighbourhood matrix yields a greater spatial correlation (moderately positive correlation) than the geopolitical matrix (weak positive correlation), and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.2.3) shows two significant large clusters with high ethnic fractionalization values. They span the countries of West and Central Africa, which is due to the highly heterogeneous population structures, where tribal and social identities are frequently ethnicized. There are also notable low value microclusters that span, respectively,

Global place	Country	Indicator
1	Liberia	0.8890
2	Uganda	0.8830
3	Togo	0.8800
Mean (76)	(Estonia)	0.4571 (0.4580)
Median (78)	Iraq	0.4460
153	Bangladesh	0.0250
154	North Korea	0.0200
155	Japan	0.0190

Japan and South Korea (monoethnic countries that had long been closed off to foreign ethnic influences) and Israel and Jordan (where the structure of the population is dominated by Jews and Arabs, respectively).

The geopolitical neighbourhood matrix cartogram (Fig. 9.2.4) shows several spatial clusters. First is a combined West and Central African cluster with high ethnic fractionalization, followed by a Euro-Atlantic cluster, where the countries mostly demonstrate low indicator values. European exceptions here include such states as Belgium, Latvia, Macedonia, Spain, Turkey, and Bosnia and Herzegovina. It is important that the indicator does not show polyethnicity as such, but rather the likelihood of randomly selected individuals being members of different ethnic groups: consequently, the list of exceptions is made up of countries where there are not many ethnic groups, but those that do exist are numerically large (the Flemish and the Walloons in Belgium; the Croats, Serbs and Bosniaks in Bosnia and Herzegovina; the Latvians and Russians in Latvia; and the Macedonians and Albanians in Macedonia). The lack of a cluster in South Asia is primarily due to the flaws in the dataset, which contains no data at all for India.

Unlike the geometric neighbourhood matrix, the geopolitical matrix makes it possible to combine the states of Europe and North America into a single cluster, which will enable us to clearly demonstrate that the United States and Canada, as countries colonized by settlers, have an ethnic structure that is not typical for the Euro-Atlantic cultural and civilizational cluster. The East Asian microcluster, however, vanishes when the geopolitical matrix is used, since the expanded ASEAN combines both monoethnic Japan and South Korea and the polyethnic states of Southeast Asia.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Ethnic fractionalization” parameter (Fig. 9.2.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The cartogram clearly shows the same clusters that were featured on The geopolitical neighbourhood matrix cartogram: the European and West African clusters. The test also identified clusters in Latin America and in island states of the Pacific.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Alcoholism	0.059	0.002	−0.274	1.273
2	Institutional foundations of democracy	0.029	0.033	−0.19	1.245
3	Urbanization	0.05	0.005	−0.229	1.049
4	Availability of electricity	0.044	0.009	−0.214	1.041
5	Access to electricity	0.145	0.000	−0.386	1.028
6	Internet users	0.126	0.000	−0.356	1.006
7	Young population	0.218	0.000	0.453	0.941
8	Number of doctors	0.162	0.000	−0.387	0.925
9	Passport power	0.108	0.000	−0.315	0.919
10	Corruption	0.052	0.005	−0.216	0.897

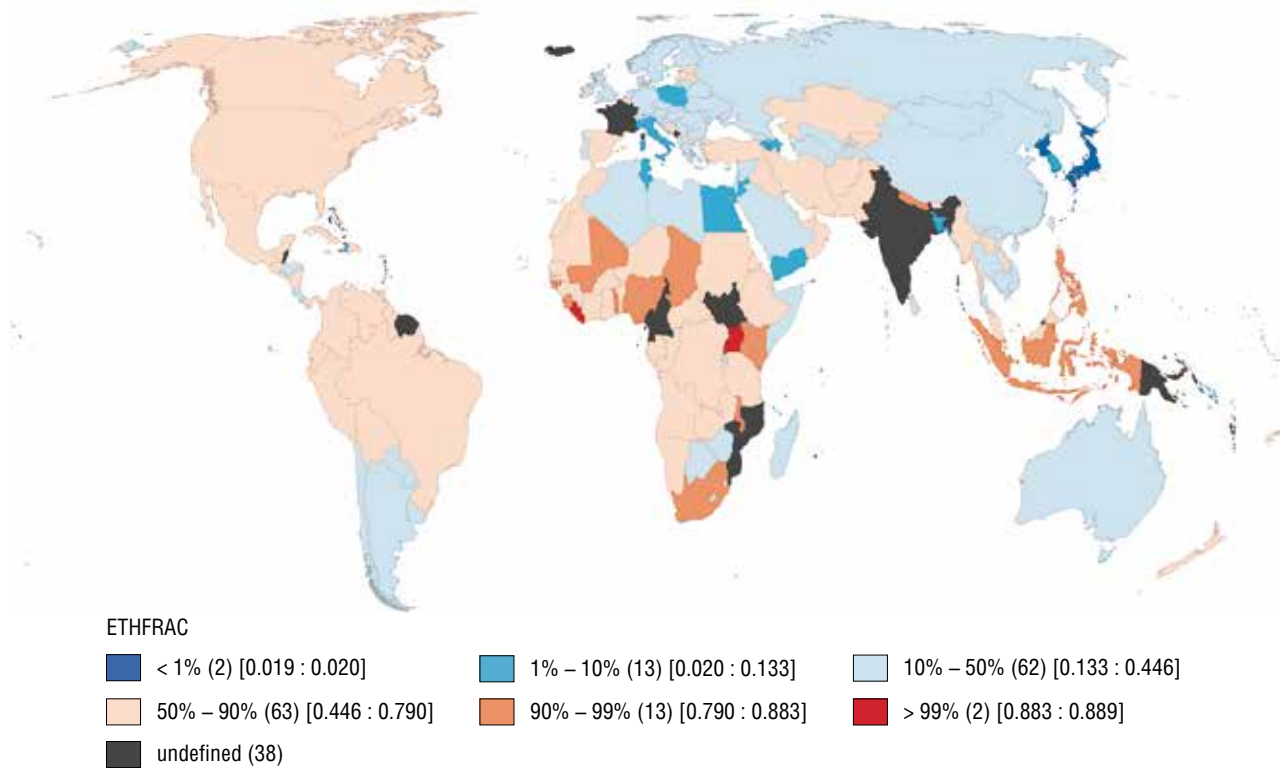


Fig. 9.2.1. Percentile cartogram for the “Ethnic fractionalization” indicator

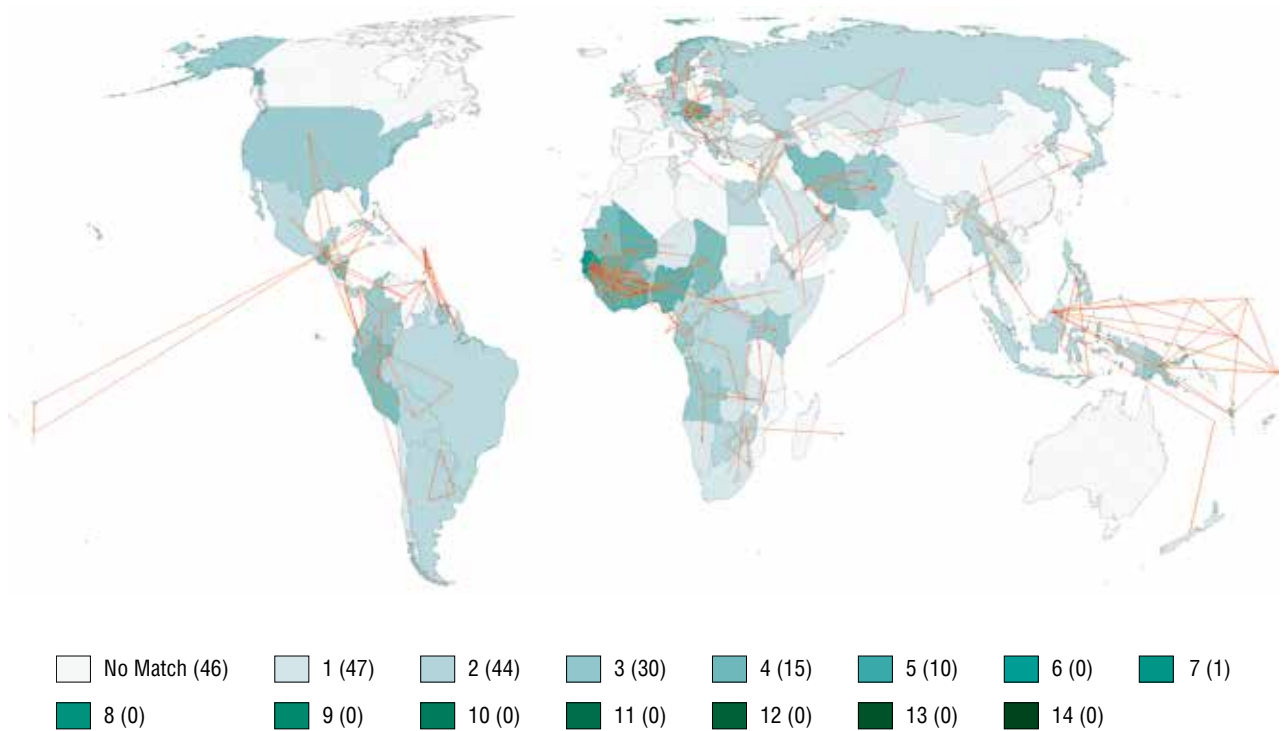


Fig. 9.2.2. Likelihood-ratio test for the “Ethnic fractionalization” parameter

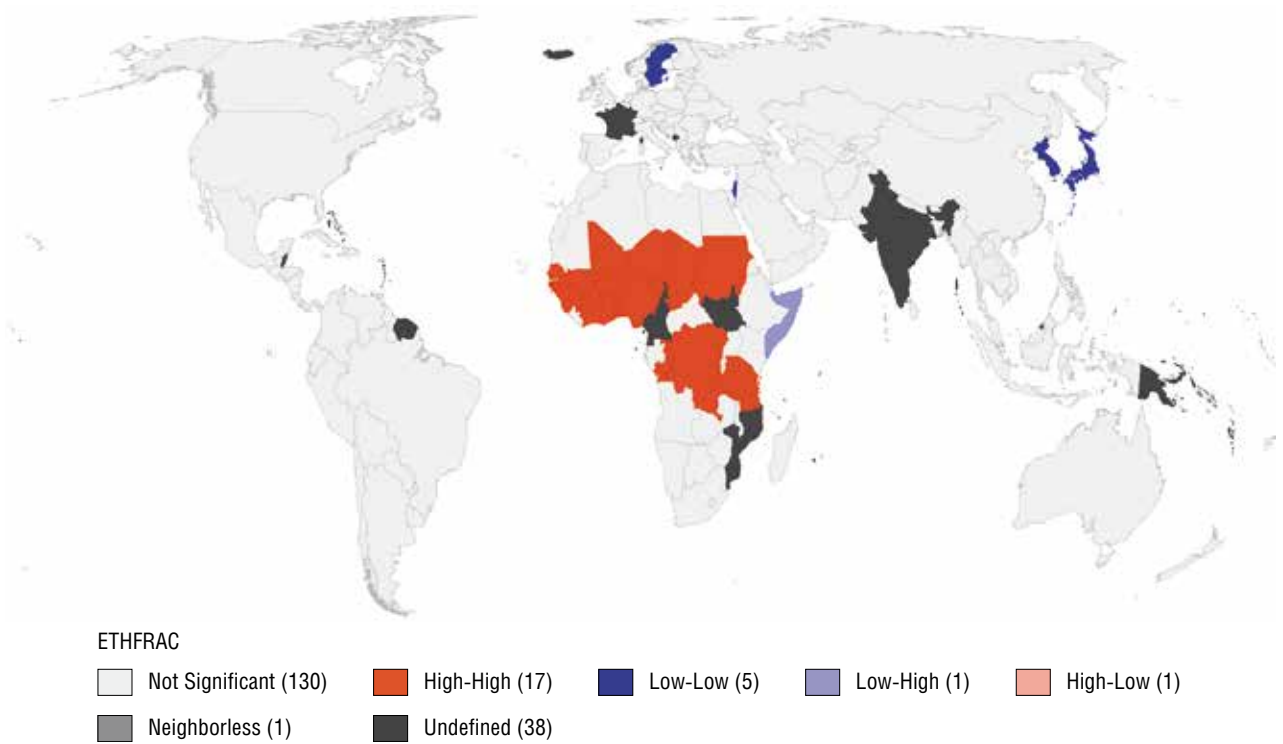


Fig. 9.2.3. “Ethnic fractionalization” spatial autocorrelation cartogram for the geometric neighbourhood matrix

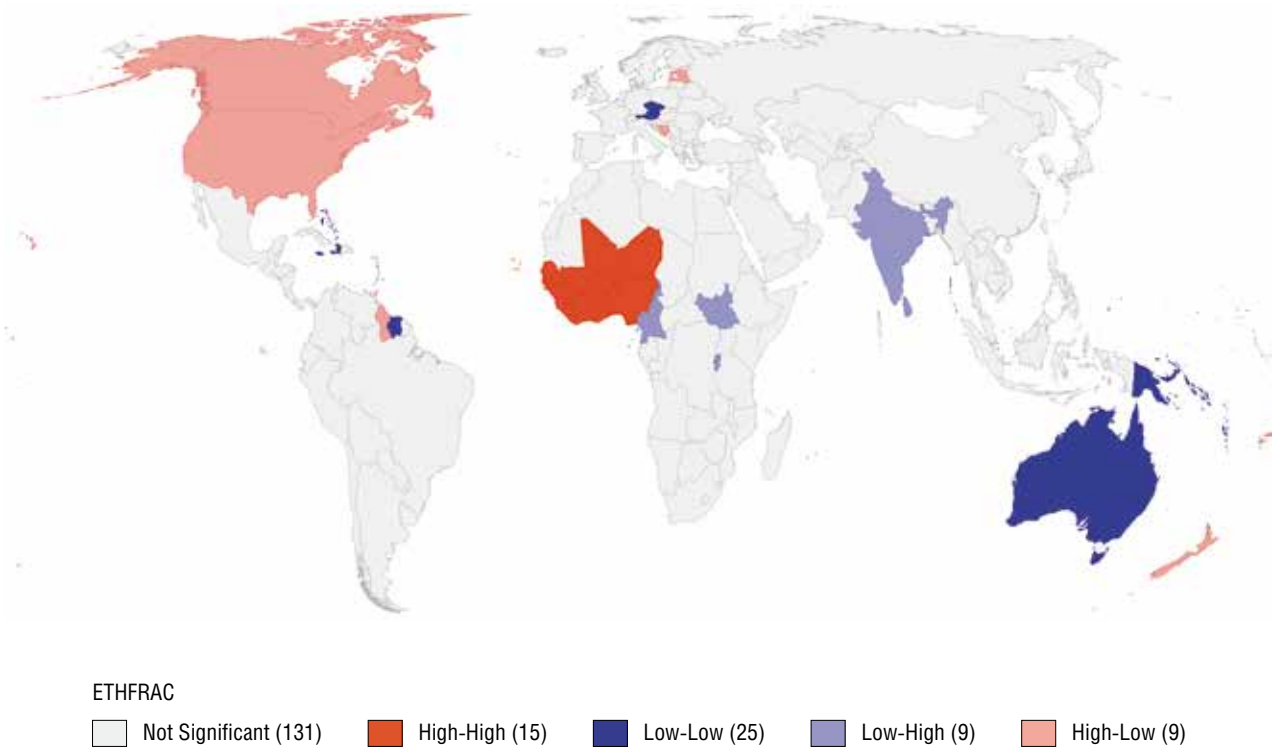


Fig. 9.2.4. “Ethnic fractionalization” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.3. Ethnic minorities

The indicator measures the share of the largest ethnic minority in a state's population and shows how pronounced the ethnic split is.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.315	0.000	0.112	0.000
Geary's C	0.713	0.000	0.883	0.000

This indicator is topped by two Latin American countries. The largest minority in Guatemala is the Indigenous Mayan population, while the notional majority is made up of several groups united by the Spanish language. In Brazil, racial categories are ethnicized, which has created a fragmented ethnorracial structure. Pardo (people of mixed origins) constitute the largest minority; both the majority and the largest minority are heterogeneous. Both countries are “leaders” in this indicator solely because several groups are combined into a single category.

The percentile cartogram (Fig. 9.3.1) shows that states with the highest indicator values are concentrated in Africa, South and West Asia, North America and South America. The causes are different in different cases: in Africa, the high values are due to colonial borders that united large groups; in the Middle East, they are due to ethnicized religious identity; and in North and South America, they are due to ethnicized racial categories.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed. We have weak positive correlations for both matrices.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.3.3) shows only one significant cluster with a low proportion of the largest ethnic minority. This cluster includes several states of Western and Southern Europe. Indeed, ethnic minorities in those countries are mostly comprised of immigrants and do not make up large monolithic groups, while the “titular” nation constitutes a stable ethnic majority. Two predictably stark exceptions are Belgium and Switzerland — polyethnic federations with several large ethnic groups, and neither of them is “titular.” Eritrea, Djibouti and Yemen also form a

Global place	Country	Indicator
1	Guatemala	0.4800
2	Brazil	0.4770
3	Comoro Islands	0.4430
Mean (71)	(Mexico)	0.1415 (0.142)
Median (86–88)	Laos, Ecuador, Thailand	0.1200
144–172	28 states	0.0000

micro-cluster, but the reasons for their high numbers are different: Eritrea and Djibouti do indeed have large ethnic minorities, while in Yemen, the ethnic group status is assigned to religions groups.

The geopolitical neighbourhood matrix cartogram (Fig. 9.3.4) shows several large spatial clusters. One — a Euro-Atlantic cluster — has a low percentage of the largest ethnic minority in its population. This geopolitical bloc has several predictable exceptions with high percentages of the largest ethnic minority, and, consequently, the significance of the ethnic “split” is higher. These are the above-mentioned Belgium and Switzerland, Estonia, Latvia, and Ukraine (with a large Russian minority), the polyethnic Bosnia and Herzegovina, Macedonia (which has a large Albanian minority), and Spain, Kosovo and Turkey where the largest minority is not significant, yet its percentage is larger than in the countries of the “blue” cluster. Finally, there are significant exceptions in North America: the United States and Canada. Another cluster, in West Africa, has, on the contrary, a major percentage of the largest ethnic minority in its population. But it has two significant exceptions: Burkina Faso and Mali. These exceptions are connected, on the one hand, with the large percentages of ethnic majorities (the Mossi and the Mandinka, respectively), and, on the other hand, with fragmented minority groups.

Unlike the geometric neighbourhood matrix, the geopolitical matrix combines European states into a single cluster (and, accordingly, demonstrates important exceptions from the typically European ethnic structure). Nevertheless, it would have been odd to claim that geopolitical orientation does in some way affect the ethnic structure of the population (and vice versa). Rather, it is a matter of notional cultural and civilizational clusters that are only partially reflected in the structure of geopolitical blocs.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Ethnic minorities” parameter (Fig. 9.3.2) identifies those instances where countries that are geographical neighbours are also countries with the closest values of the indicator under consideration. The relevant cartogram clearly shows the same clusters as are visible on the geopolitical neighbourhood matrix: Western European and West African clusters. The test also identified clusters in South America and in the island states of the Pacific.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Access to electricity	0.033	0.018	−0.208	1.311
2	Motorways	0.03	0.022	−0.187	1.166
3	Infant mortality	0.045	0.005	0.214	1.018
4	Bioethical freedom	0.047	0.007	−0.207	0.912
5	Years at school	0.071	0.000	−0.248	0.866
6	Mobile subscribers	0.056	0.002	−0.215	0.825
7	Railway network	0.07	0.002	−0.236	0.796
8	Primary school dropouts	0.058	0.003	0.214	0.790
9	Internet users	0.076	0.000	−0.238	0.745
10	Conflictogenity	0.036	0.017	0.163	0.738

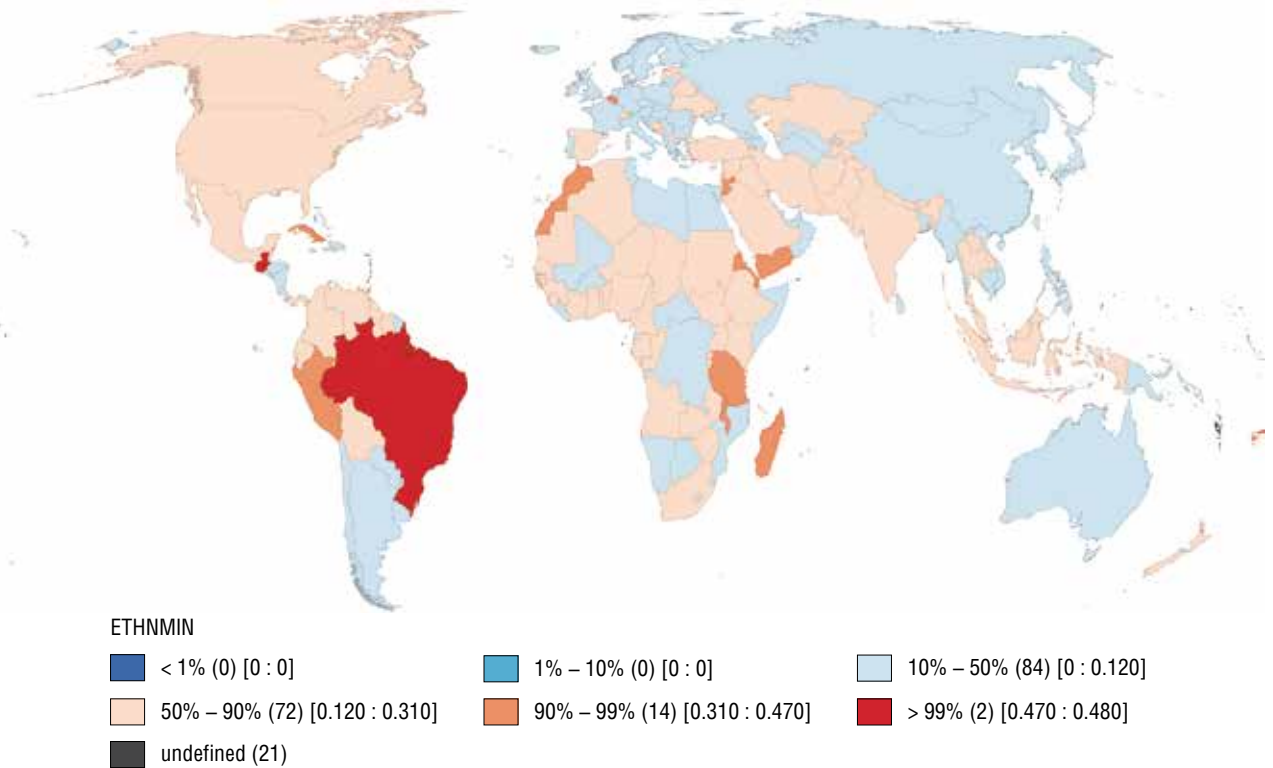


Fig. 9.3.1. Percentile cartogram for the “Ethnic minorities” indicator

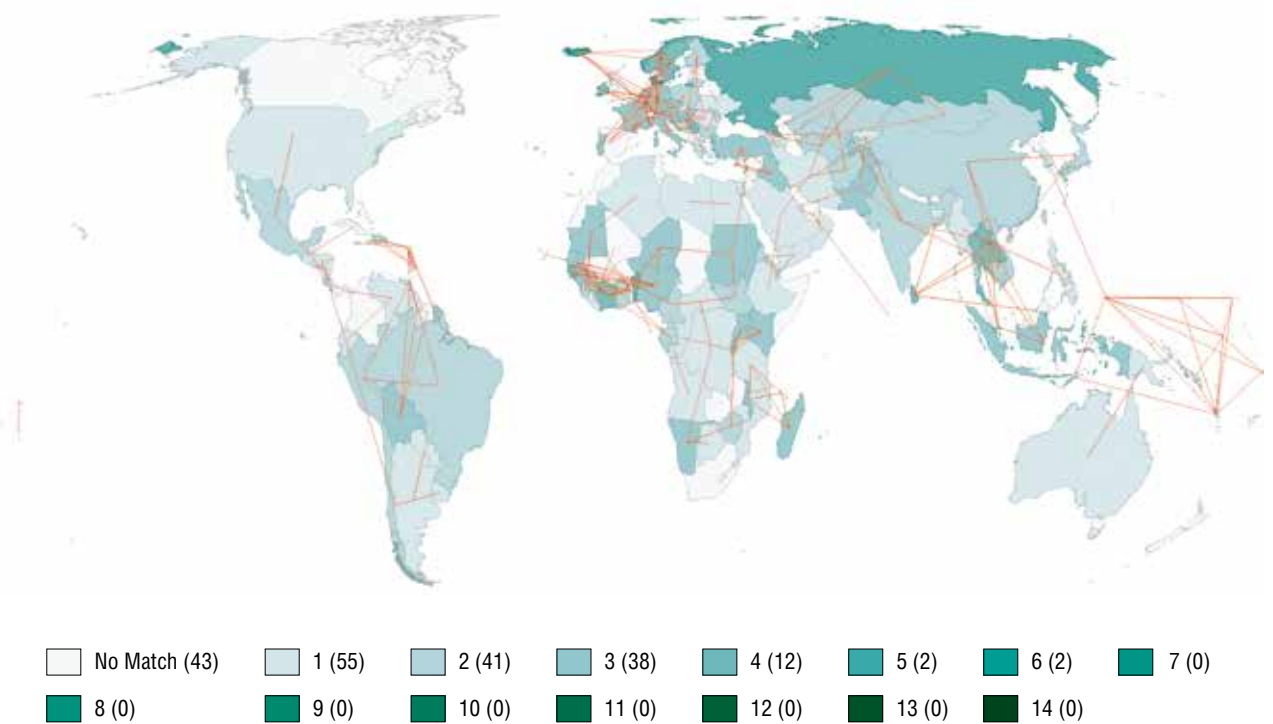


Fig. 9.3.2. Likelihood-ratio test for the “Ethnic minorities” parameter

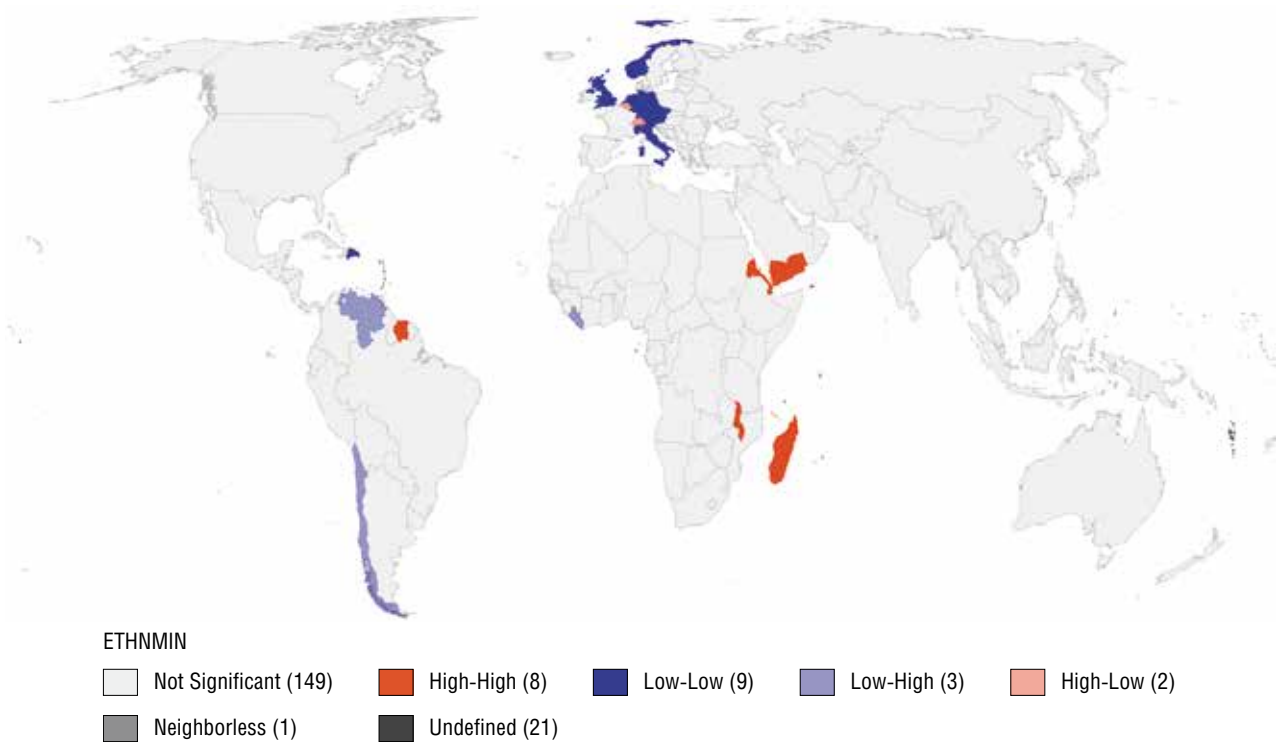


Fig. 9.3.3. “Ethnic minorities” spatial autocorrelation cartogram for the geometric neighbourhood matrix

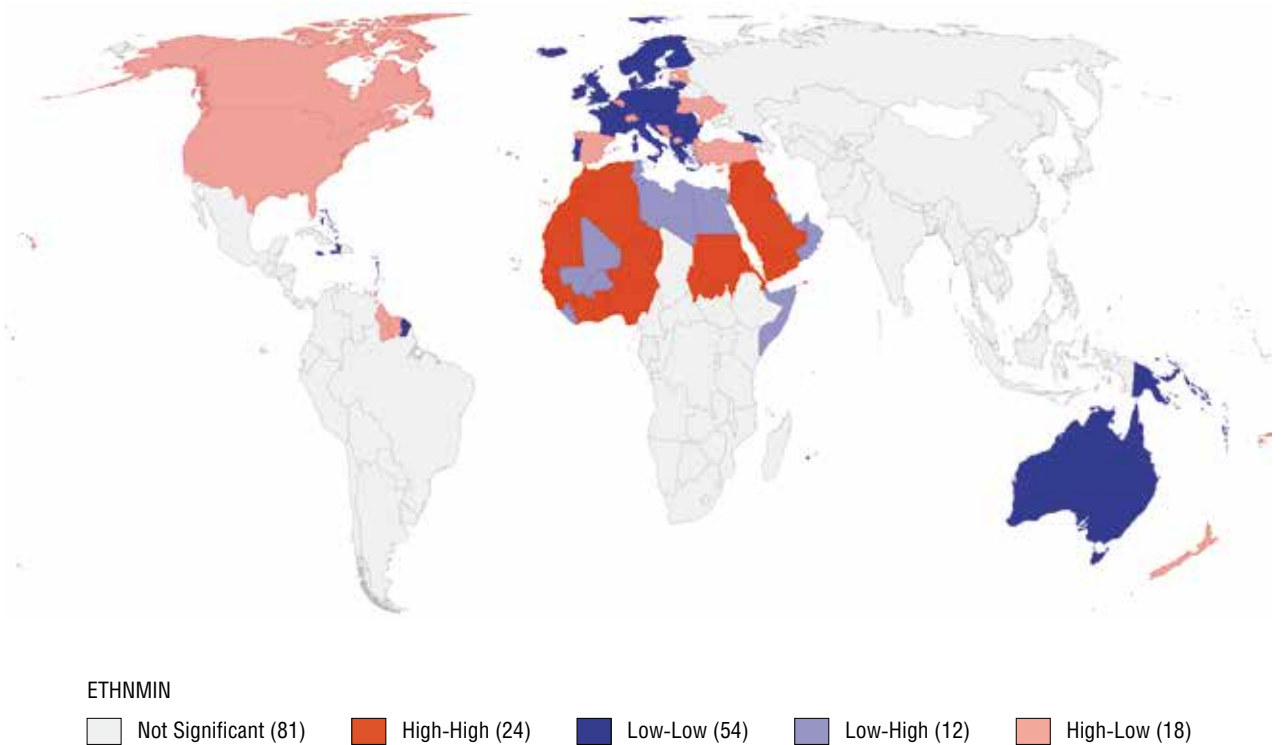


Fig. 9.3.4. “Ethnic minorities” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.4. Linguistic diversity

As part of the human development potential, the linguistic diversity coefficient demonstrates potential difficulties in resolving communication between speakers of different languages in a single state. It is calculated by the percentage of each language's native speakers in a given population.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.469	0.000	0.301	0.000
Geary's C	0.526	0.000	0.696	0.000

The percentile cartogram (Fig. 9.4.1) shows that the largest concentration of different languages within a single state is observed in sub-Saharan Africa. This region, inhabited by speakers of one sixth of all the languages in the world, preserves the languages of different native groups. Another such locus is India, where, in addition to Hindi and English, another 22 languages are recognized at the level of states, and there are a tremendous number of local languages and dialects. The highest indicator value is recorded in Papua New Guinea, which has over 800 languages and has implemented a policy of advancing the Tok Pisin language, which is similar to most Melanesian languages, as the country's lingua franca.

The geometric neighbourhood matrix (Moran's I) yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.4.3) shows two clusters with high levels of linguistic differentiation: sub-Saharan African states and Southeast Asian states.

At the same time, the geopolitical neighbourhood matrix cartogram (Fig. 9.4.4) identifies clusters with a relatively low linguistic differentiation: these are Spanish- and Portuguese-speaking countries of Latin and Central America, Mexico, and the Euro-Atlantic bloc, where countries use mostly one or two languages.

Global place	Country	Indicator (coefficient)
1	Papua New Guinea	0.988
2	Cameroon	0.975
3	Vanuatu	0.972
Median (96–97)	Uzbekistan, Netherlands	0.4640
Mean (99–100)	(Turkmenistan, Marshall Islands)	0.4573 (0.457)
188	Iceland	0.002
189	Cuba	0.001
190–192	North Korea, San Marino, Haiti	0

Bolivia constitutes a curious exception in Latin America: it has 43 living languages, 37 of which have official status; native languages receive governmental support, are taught at schools and used in government bodies (the most common of these are Aymara, Quechua and Guarani). Europe has some exceptions. One is Switzerland, which has four official languages (Switzerland, though, has a very clear governmental language policy for all of them), and another is Italy, where a large chunk of population in the south speaks local languages and dialects, although this does not constitute a problem since everyone speaks “standard Italian.” Other standouts are Belgium (three official languages) and the Netherlands (due to its regional languages and overseas territories Bonaire, Curaçao and Aruba). Ukraine, Estonia and Latvia stand out in the NATO–EU bloc due to a large percentage of Russian-speaking population.

A likelihood-ratio test for geometric and geopolitical neighbourhood for the “Linguistic diversity” parameter (Fig. 9.4.2) identifies neighbourhood nodes of linguistic diversity coefficient among the countries of Tropical Africa, Central and Latin America and Europe. Notably, however, countries of North America and South and East Asia have different indicator values.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Democracy Index	0.082	0.000	−0.303	1.126
2	Mobile subscribers	0.039	0.010	−0.187	0.904
3	Access to electricity	0.192	0.000	−0.401	0.839
4	Healthcare spending	0.047	0.003	−0.196	0.818
5	Years at school	0.182	0.000	−0.384	0.811
6	Marriage	0.093	0.000	0.270	0.787
7	Passport power	0.191	0.000	−0.386	0.781
8	Publication activity	0.054	0.001	−0.205	0.778
9	Infant mortality	0.225	0.000	0.418	0.776
10	Women in politics	0.031	0.014	−0.154	0.757

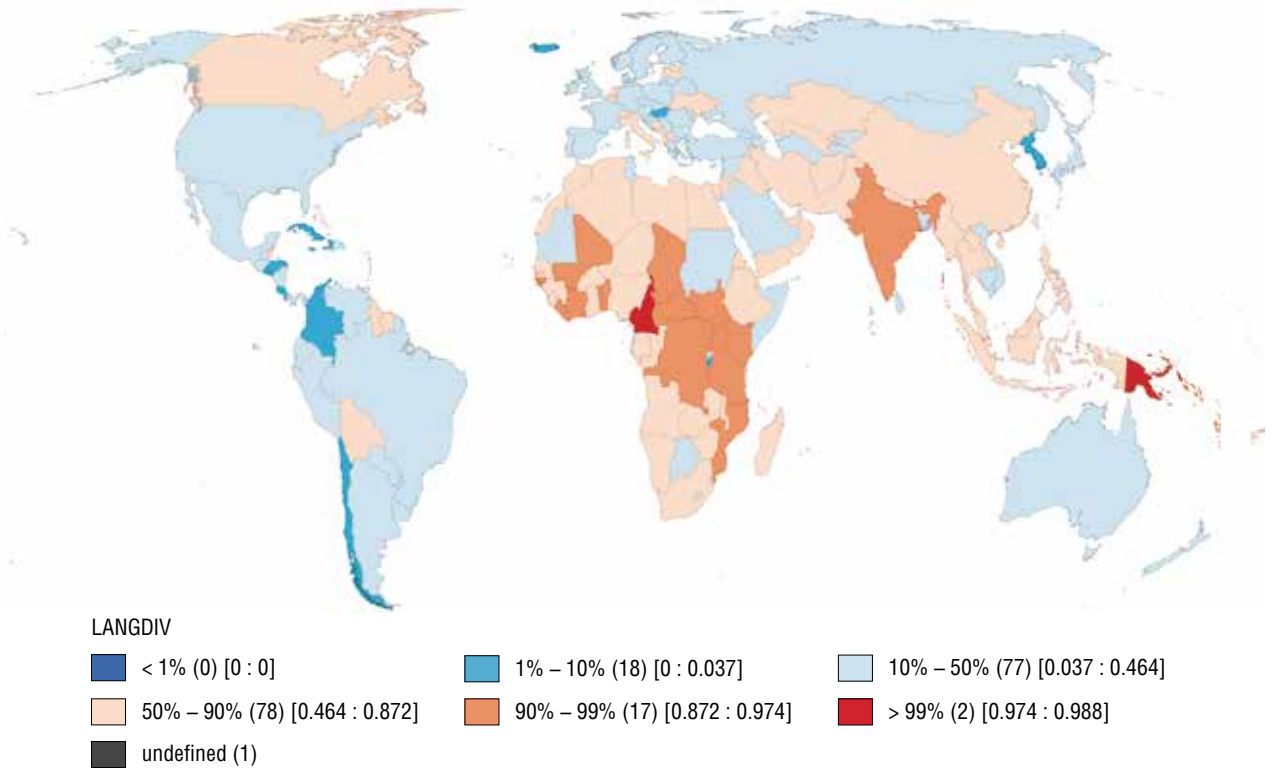


Fig. 9.4.1. Percentile cartogram for the “Linguistic diversity” indicator

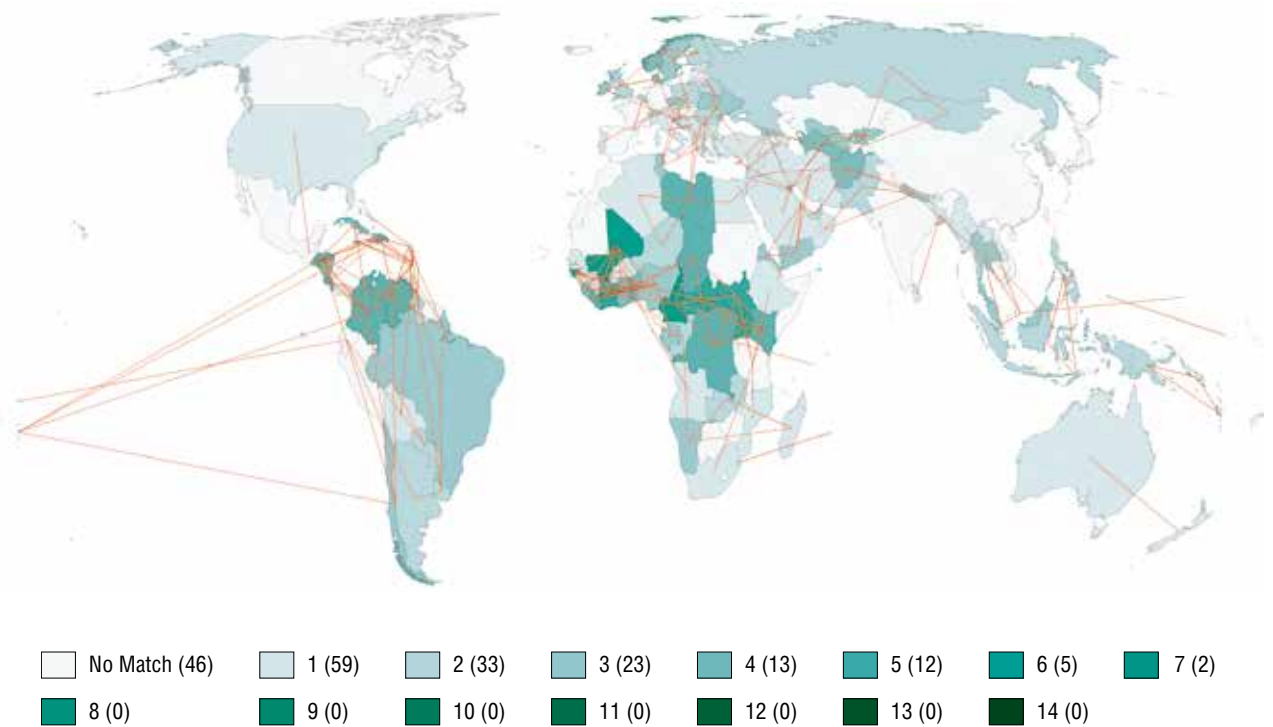


Fig. 9.4.2. Likelihood-ratio test for the “Linguistic diversity” parameter

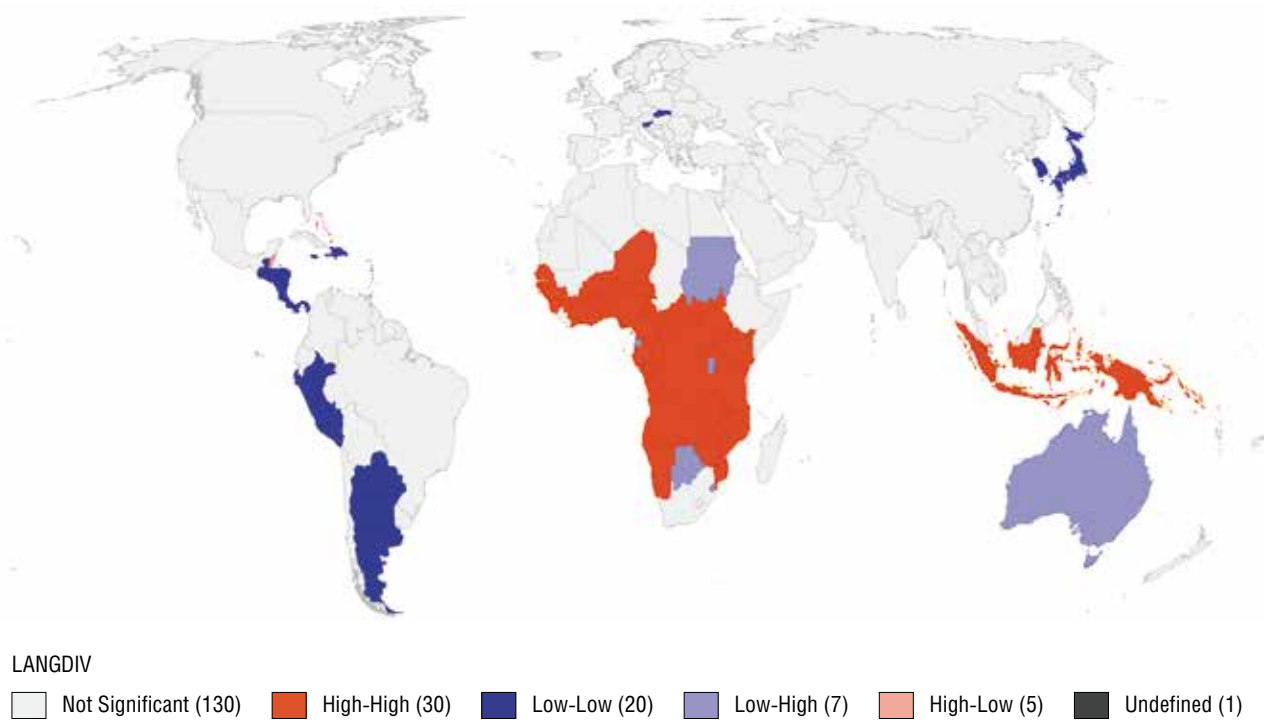


Fig. 9.4.3. “Linguistic diversity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

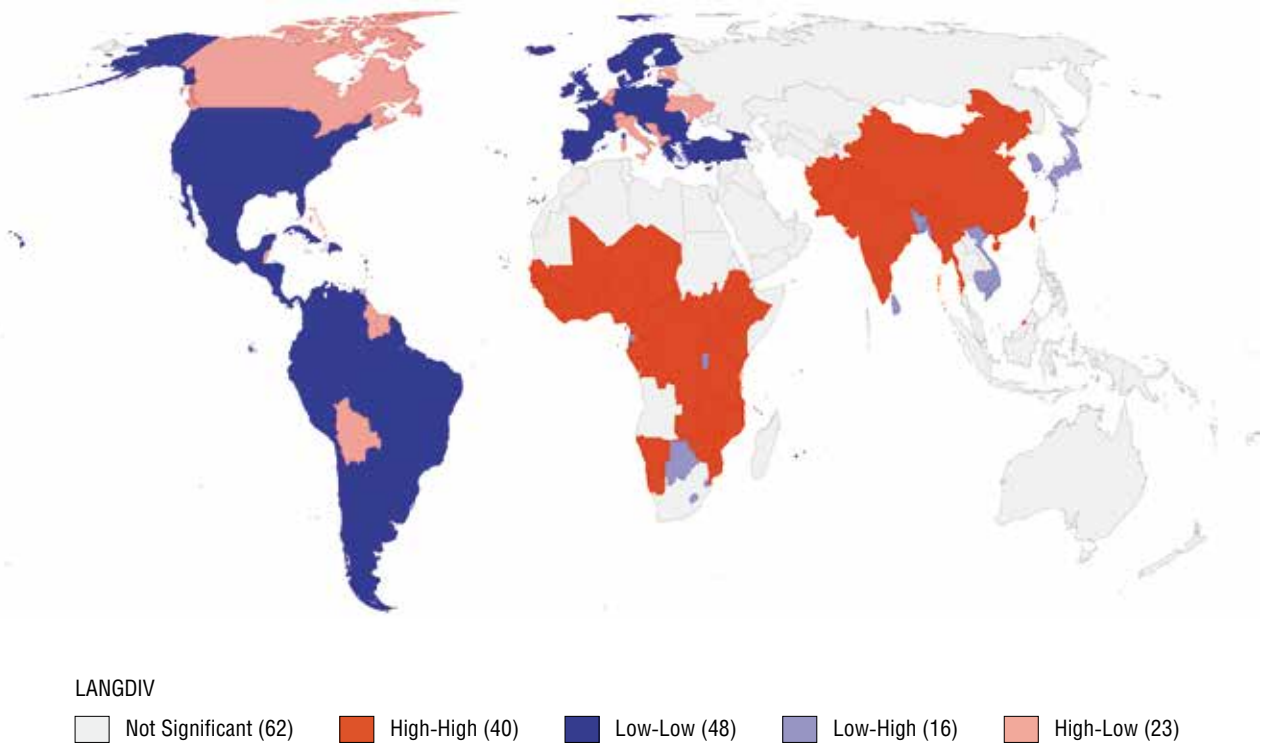


Fig. 9.4.4. “Linguistic diversity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.5. Religious diversity

The religious diversity index allows us to consider states in terms of the need to coordinate policies within a multid denominational space, which frequently results in difficulties in state-building and even in open domestic conflicts.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.236	0.000	0.064	0.012
Geary's C	0.758	0.000	0.931	0.012

The percentile cartogram (Fig. 9.5.1) shows that several African states stand out when considered in terms of religious diversity. These are countries where religious beliefs imported from Europe mix with traditional local religious systems, and also East Asian states: China, for instance, has traditional religions, Confucianism and Taoism, and also Buddhism, Islam, Christianity, and the religions of ethnic minorities. At the same time, the Islamic states of the Middle East and North Africa are fairly monolithic, as are most states of Latin America, where Catholicism has been strong since the times of colonization. The first place in the ranking belongs to Singapore, which has a large percentage of entrepreneurs of various ethnic origins and religious beliefs because of the country's favourable investment climate, the activities of various transnational corporations, and the rapidly growing economy.

Vietnam, which stands apart on the percentile cartogram, has a complex system of folk beliefs that intertwine with Buddhism and other religions. Generally, countries with a high level of denominational differences can be divided into fairly highly developed states capable of ensuring freedom of religion, and underdeveloped states where diversity comes from a large number of local religious cults.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Global place	Country	Indicator (index)
1	Singapore	9.0
2	Vietnam	7.7
3	Suriname	7.6
Mean (82–85)	(Kenya, Guinea, Ukraine, Norway)	3.0622 (3.1)
Median (94–97)	Uganda, Zimbabwe, Palau, Haiti	2.7
183–186	Papua New Guinea, Iraq, Yemen, Mauritania	0.2
187–192	East Timor, Afghanistan, Iran, Somalia, Romania, Tunisia	0.1
193	Morocco	0

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.5.3) contains noticeable clusters in North Africa where religious diversity is low, which is due to the predominance of Islam in these regions. In Western Africa, there is a cluster of countries that score high on the religious diversity index. This can be explained by the coexistence of Islam and Christianity in these regions (the number of people professing each of these religions is more or less equal in Nigeria, while in Ghana there are more Christians than Muslims), as well as by the role of traditional beliefs (in Togo, Benin and Burkina Faso, the number of people who identify as followers of local religions ranges from 20% to 50%).

The geopolitical neighbourhood matrix (Fig. 9.5.4) allows us to identify exceptions in the European cluster, where religions coexist by default within the framework of the democratic principle of religious freedom. Religious diversity is rather high here, due in part to the recent migration trends. However, low scores are evident for Catholic countries — Croatia, Ireland, Poland and Portugal. Note also the countries with a predominantly Orthodox population (Serbia, Greece and Romania). Iceland is a particularly interesting case, where over 90% of the population belongs to the Evangelical Lutheran Church, making it low on the religious diversity index and an “outlier” compared to other European states. In contrast, Russia, Kazakhstan and Belarus, demonstrate high levels of religious diversity for their bloc: the percentage of people practicing the predominant religion in these countries is far lower, for example, than in Orthodox Armenia and Muslim Tajikistan.

The likelihood-ratio test for geometry and religious diversity (Fig. 9.5.2) confirms the existence of clusters in South and Central America, Europe, Africa, the Middle East, and Southeast Asia. At the same time, Canada is closer to European countries on this indicator than to its closest geopolitical partner, the United States.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Agriculture	0.025	0.034	0.196	1.559
2	Industry	0.039	0.007	0.205	1.068
3	IMF voting power	0.038	0.007	0.158	0.649
4	Export	0.080	0.000	0.224	0.624
5	Unused export potential	0.081	0.000	0.223	0.614
6	Import	0.071	0.000	0.202	0.576
7	Unemployment	0.047	0.004	-0.153	0.499
8	Women's unemployment	0.065	0.001	-0.171	0.449
9	Royalties to foreign copyright holders	0.036	0.019	0.127	0.445
10	Air passengers	0.027	0.042	0.104	0.400

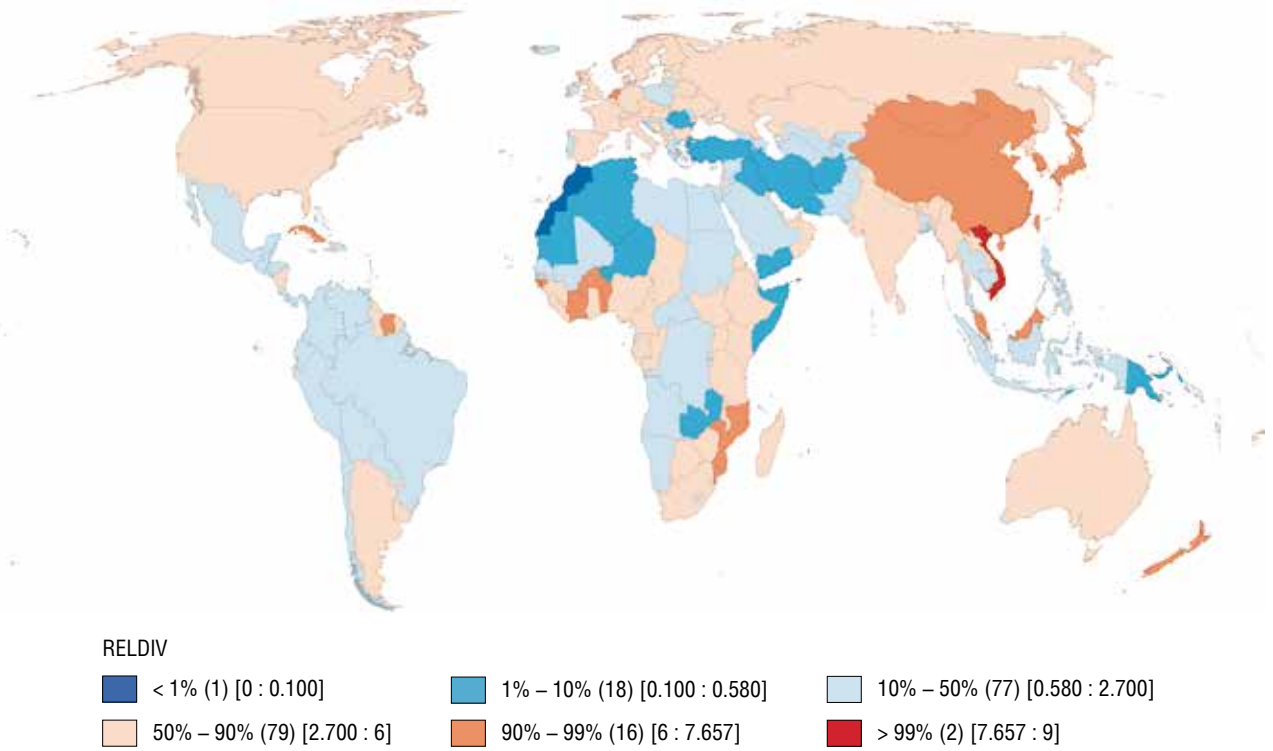


Fig. 9.5.1. Percentile cartogram for the “Religious diversity” indicator

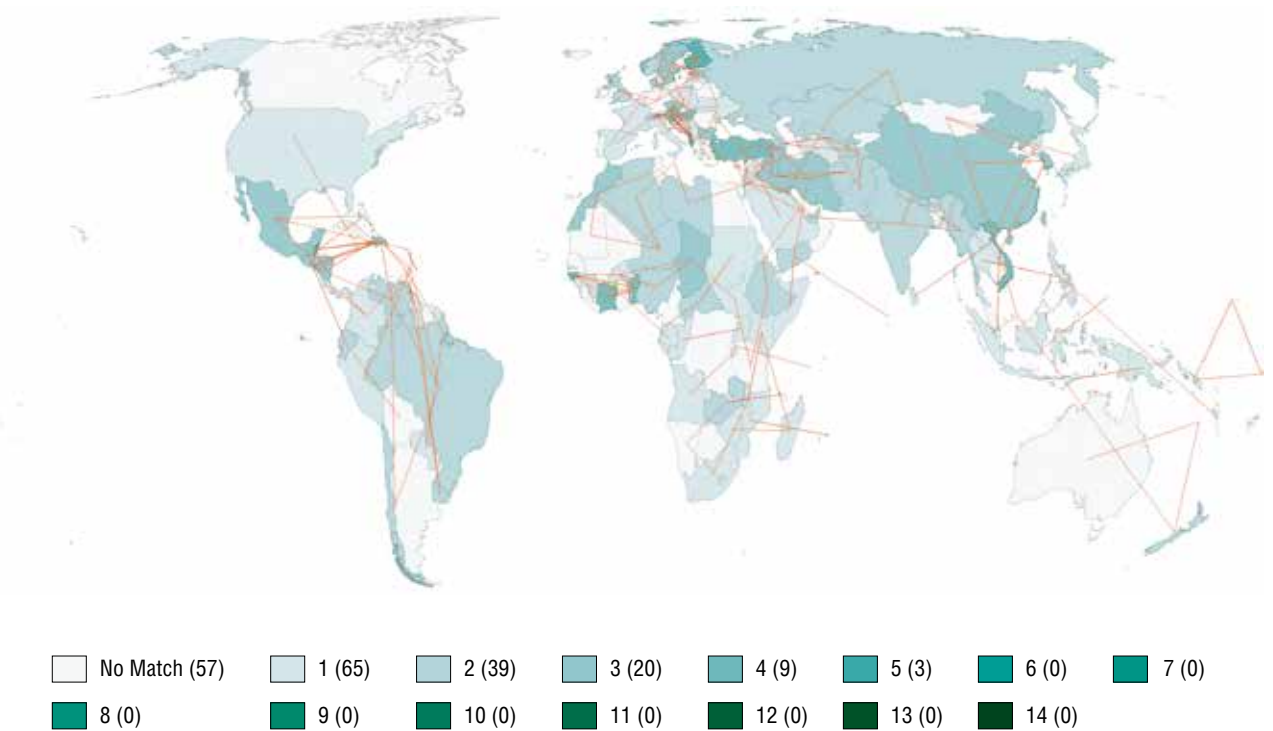


Fig. 9.5.2. Likelihood-ratio test for the “Religious diversity” parameter

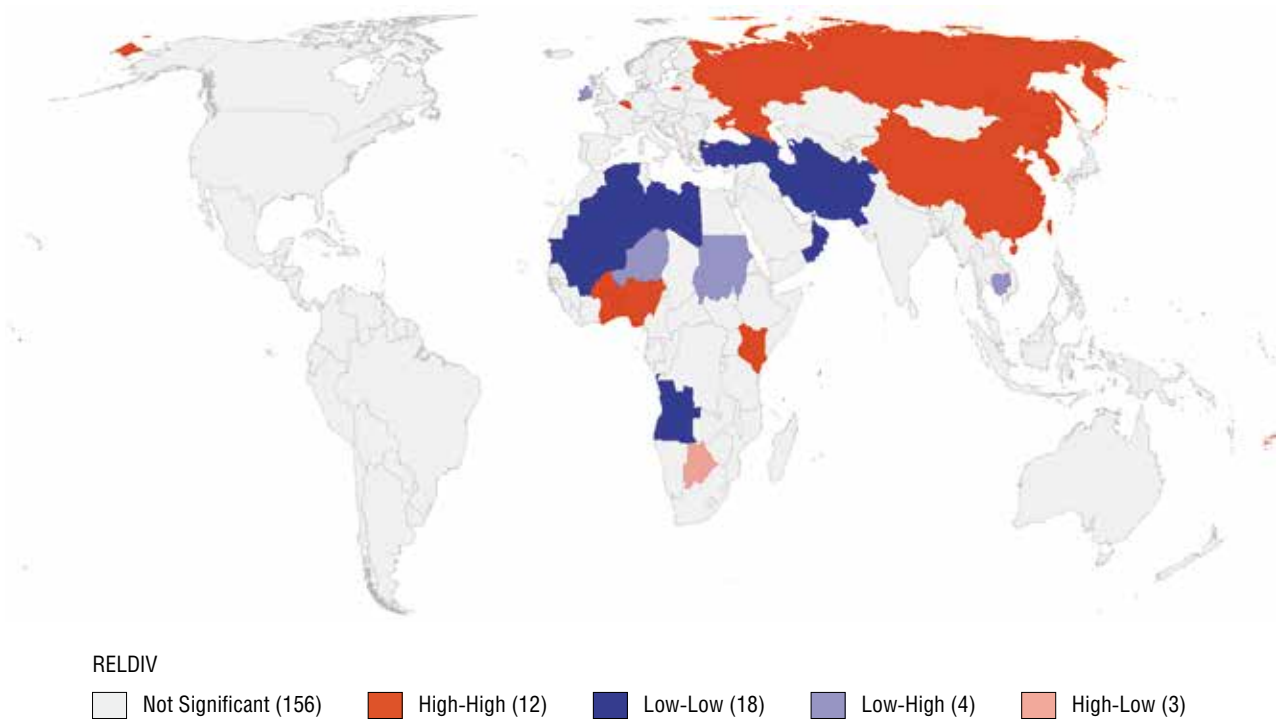


Fig. 9.5.3. “Religious diversity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

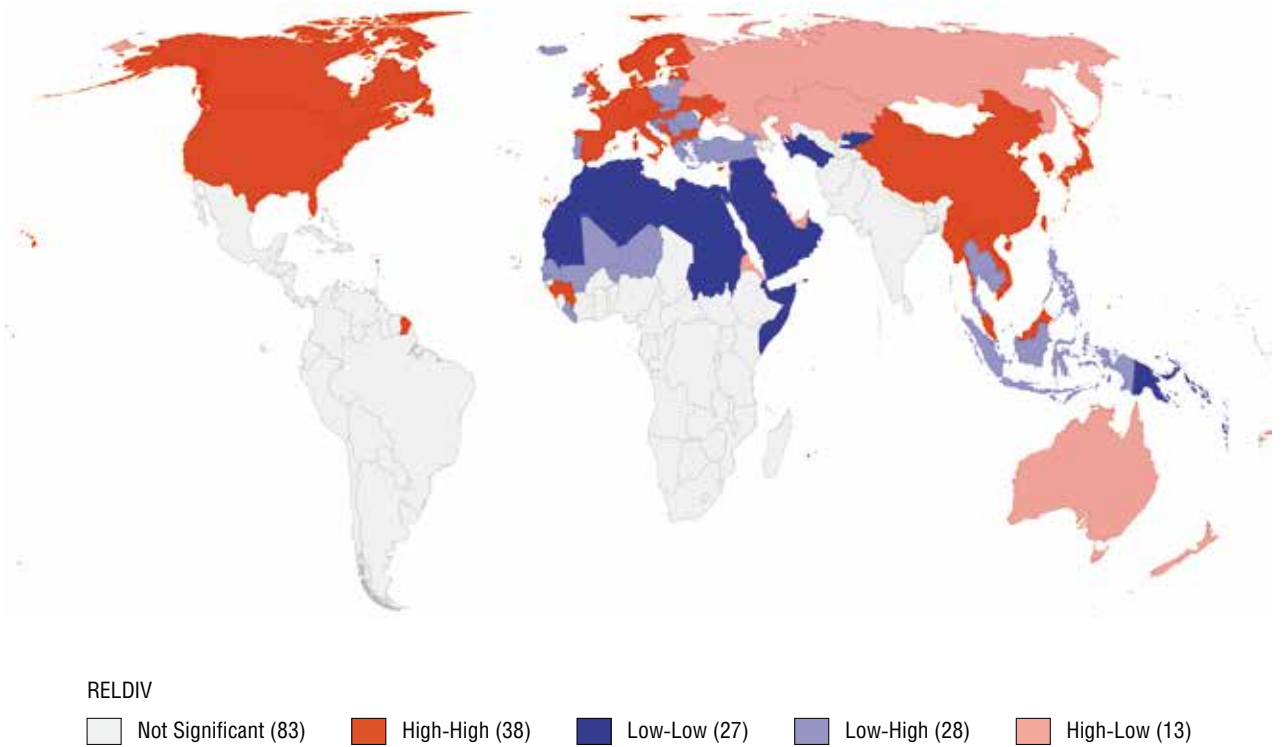


Fig. 9.5.4. “Religious diversity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.6. Cultural exports

The share of exports of cultural goods as a percentage of a country's total exports allows us to judge the ability of that country to produce goods of cultural value — that is, it can give us an idea of the level of sociocultural development of society and the “influence” of cultural characteristics.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.136	0.000	0.040	0.042
Geary's C	0.823	0.066	0.955	0.042

The percentile cartogram (Fig. 9.6.1) shows that a moderately high level of exports of cultural goods can be observed in Western countries, where the trend has historically been to preserve and expand cultural heritage, both traditional art and modern multimedia products. Since handicraft products count as objects of cultural heritage, countries such as the Philippines, China, India and Turkey — places where a wide variety of goods, including software artefacts and fashion items — score high on this indicator.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.6.3) contains a cluster of West African states that belong to the group of the poorest countries in the world. The exports of these countries are primarily concentrated on agriculture, and cultural heritage primarily exists in the form of intangible goods — oral folklore, traditional dances and other phenomena that cannot be counted in monetary terms.

Global place	Country	Indicator (share)
1	Barbados	16.328
2	Saint Lucia	8.712
3	India	5.269
Mean (31)	(Austria)	0.9054 (0.909)
Median (70)	(Philippines)	0.3195 (0.316)
135–136	Mali, Niger	0.007
137	Ghana	0.006
138	Guyana	0.005

In contrast to the geometric neighbourhood matrix, the geopolitical neighbourhood matrix cartogram (Fig. 9.6.4) features a cluster of Latin American states whose exports are dominated by crops and natural resources. Bolivia is an exception here, as precious stones and metals, as well as cultural items made from them, account for over 15% of its exports. Additionally, France and the United Kingdom stand out in the European cluster; despite the centuries of enmity and rivalry between the two countries, they lead in terms of the share of cultural exports, including among themselves. Cyprus is also worthy of note here, as its favourable tax situation means that objects of cultural value are manufactured in a large number of places. Poland, which actively exports printed products, is similarly an outlier here.

The likelihood-ratio test for the “Cultural exports” parameter (Fig. 9.6.2) highlights the links between Latin American countries, as well as those between Latin America and North America, and between European countries, including Russia, as well as the knot of the countries of Southeast Asia and Oceania. As is the case with many other indicators in this section, the most obvious coincidence between the indicator values of geometric neighbours is observed in the countries of Africa. At the same time, no coincidence is observed in the indicators for the countries of Central and East Asia, which points towards heterogeneity in the level of exports of cultural objects.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Railway network	0.037	0.048	0.171	0.795
2	Access to electricity	0.033	0.032	0.142	0.605
3	Motorways	0.060	0.004	0.183	0.556
4	Renewable energy	0.032	0.037	-0.123	0.480
5	Children	0.040	0.019	-0.131	0.424
6	Life expectancy	0.035	0.029	0.114	0.369
7	Population growth	0.034	0.031	-0.103	0.313
8	Depletion of natural resources	0.040	0.022	-0.099	0.245
9	R&D spending	0.052	0.015	0.101	0.196
10	State debt	0.059	0.005	0.104	0.185

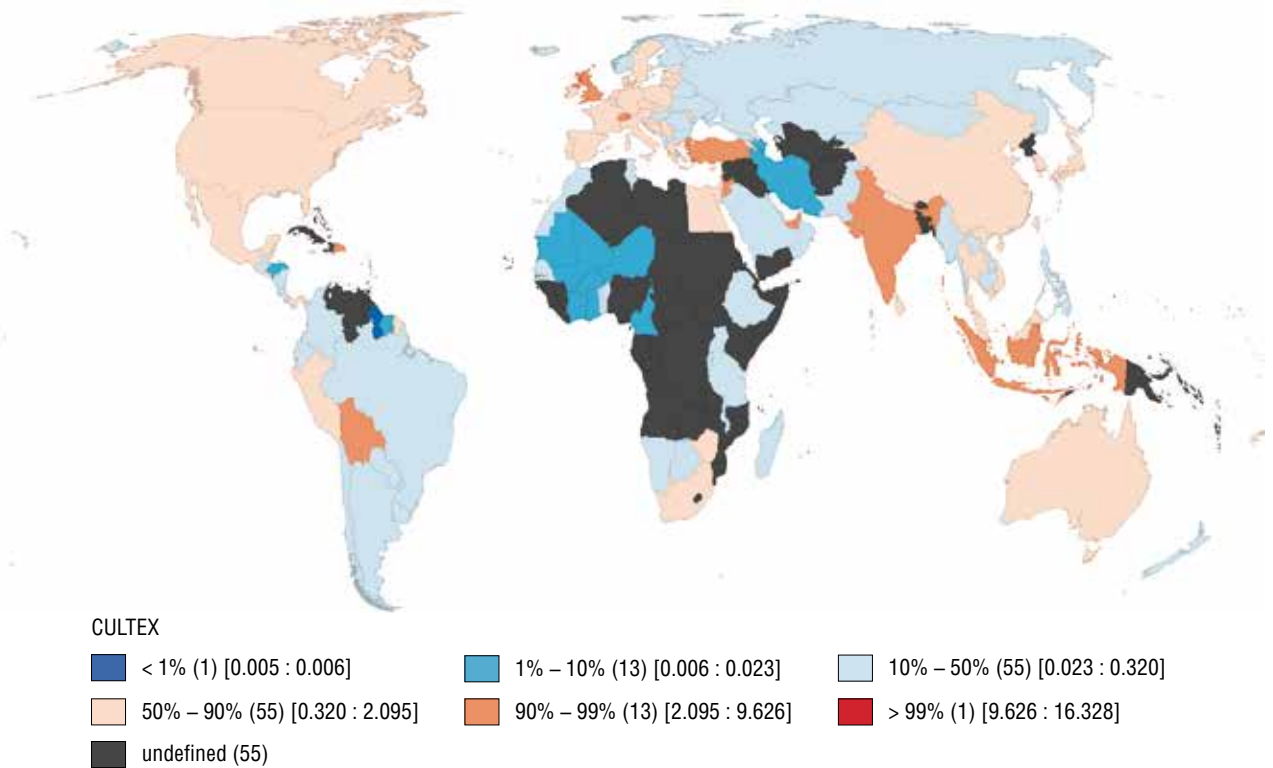


Fig. 9.6.1. Percentile cartogram for the “Cultural exports” indicator

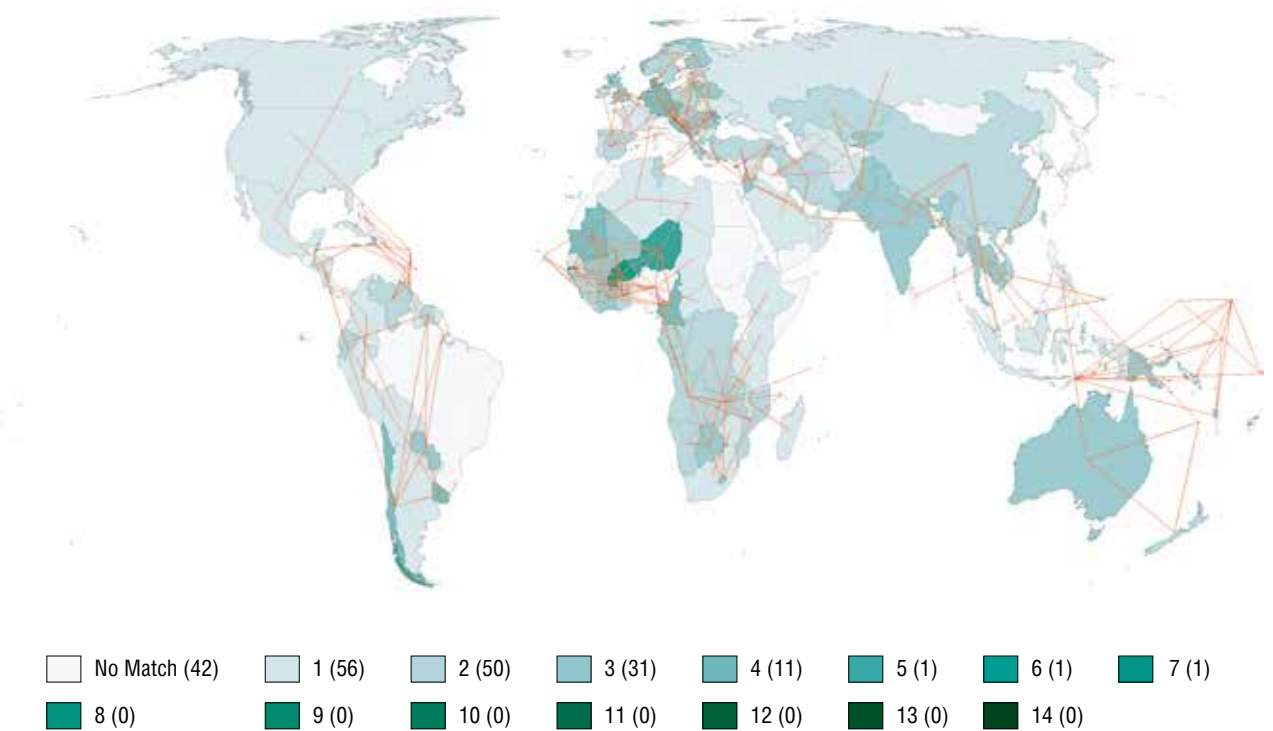


Fig. 9.6.2. Likelihood-ratio test for the “Cultural exports” parameter

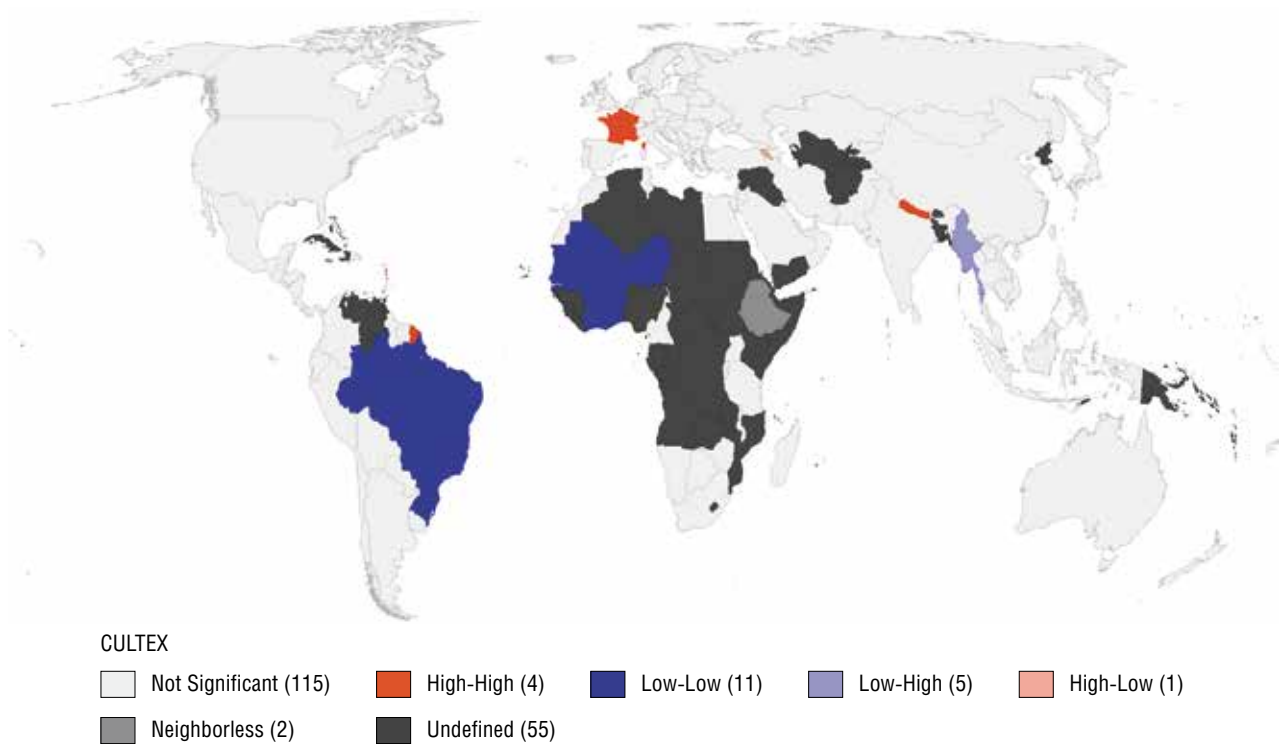


Fig. 9.6.3. “Cultural exports” spatial autocorrelation cartogram for the geometric neighbourhood matrix

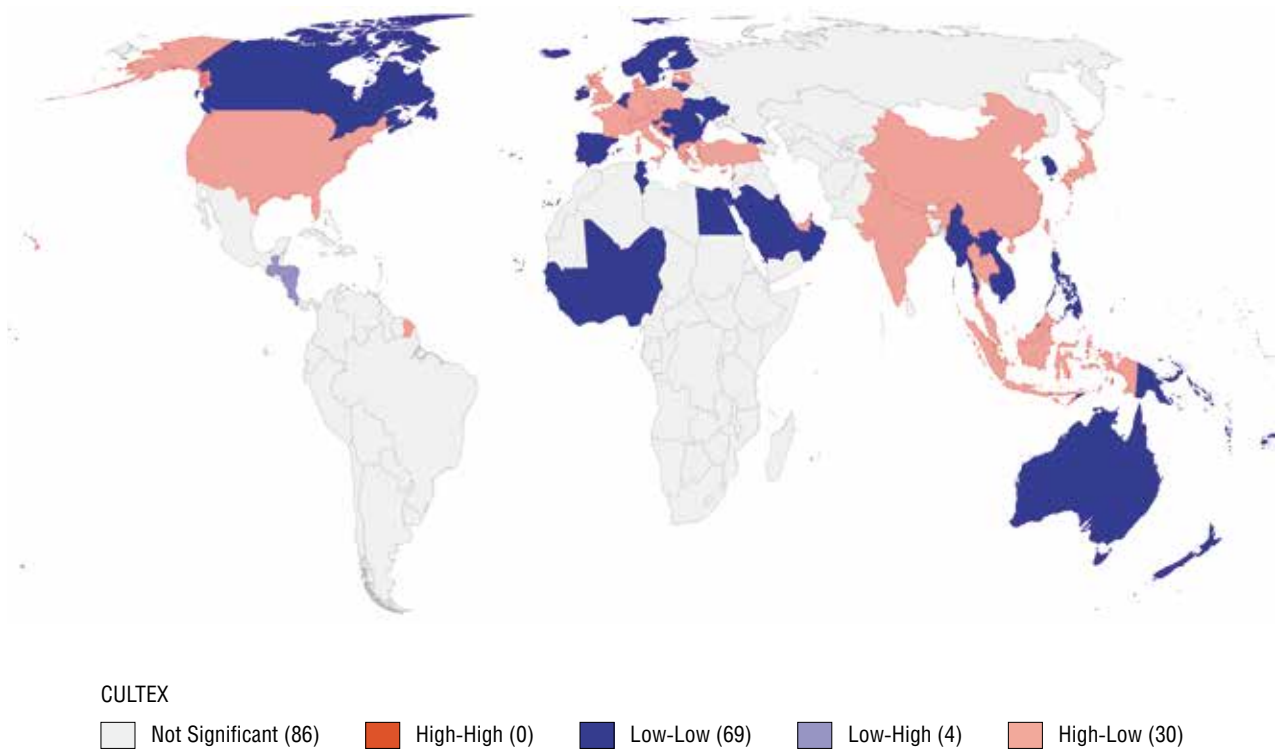


Fig. 9.6.4. “Cultural exports” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.7. Bioethical freedom

The bioethical freedom index is an indicator of personal freedom in decision-making, representing a bioethical dilemma, and also indirectly reflects the freedom of scientific research on relevant issues.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.534	0.000	0.483	0.000
Geary's C	0.460	0.000	0.514	0.000

The percentile cartogram in Fig. 9.7.1 shows that there is a high level of bioethical freedom in Russia, where there are no legal restrictions on stem cell research for therapeutic cloning and further use in medicine, elective abortions are allowed and are included in the system of mandatory medical insurance, and surrogate motherhood is permitted. All these factors allow Russia to score high on the bioethical freedom index compared to other countries. A similar situation is observed in neighbouring Belarus, Ukraine and Kazakhstan. In addition, Canada, Belgium, the Netherlands, the United States and Australia are noteworthy, as euthanasia has been legalized in these countries (although not in all states in America and Australia). However, the United States does not rank high on the list, as the situation with the legalization of elective abortion differs from state to state. Meanwhile, abortion is prohibited by law without exception in El Salvador, Nicaragua, the Dominican Republic and Malta, as are other actions that fall under the criteria for determining bioethical freedom. Latin America as a whole scores lower than other regions, largely due to the differences in the legal status of elective abortion. Legislative restrictions based on religious considerations also exist in certain countries of the Middle East, which can be seen in the cartogram.

The geometric neighbourhood matrix (Fig. 9.7.3) yields a greater spatial correlation than the geopolitical neighbourhood matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

On the spatial autocorrelation cartogram for the geometric neighbourhood matrix, we see a single cluster of European countries, some post-Soviet countries, China, Japan and North Korea. We should note

Global place	Country	Indicator (indicator value)
1–3	Canada, Netherlands, Belgium	95.00
4	Australia	93.13
5	Portugal	91.88
Mean (69)	(Japan)	44.291 (47.50)
Median (78–116)	38 countries	31.25
120–122	Paraguay, Iran, Venezuela	20.63
123–156	33 countries	15.63
157–161	Dominican Republic, El Salvador, Malta, Nicaragua, Gabon	0

that elective abortion (which carries the most weight in this indicator) is legal in all of the countries in this cluster. Conversely, Poland and Finland posted low scores for this indicator, thus “falling out” of the cluster, as certain medical or social grounds are required for the procedure to go ahead.

The EU–NATO bloc stands out once again on the cartogram for the geopolitical neighbourhood matrix (Fig. 9.7.4), with Poland and Finland once again proving to be exceptions. Additionally, Australia and New Zealand, where abortion and euthanasia have been legalized (although euthanasia is only legal in some states in Australia), scored high for this indicator compared to the other countries in their bloc. Furthermore, Australia ranks fourth in the world in the number of stem cell clinical trials (the United States is in first place). Thus, the cartogram shows that the countries of Europe and the Anglo-Saxon world are leaders in terms of individual freedoms. This could indicate the development of a responsible society in these countries, where the state can “delegate” solutions to the most complex bioethical issues to the people themselves.

The likelihood-ratio test for the geometric neighbourhood and “Bioethical freedom” indicator (Fig. 9.7.2) similarly shows the connection between the states of Europe, and, interestingly, the “tangle of connections” is localized in the Balkans, where the legislation related to bioethical freedom is almost identical, but not so removed from the general trends of surrounding countries as to form their own cluster. Even so, it is noteworthy that, together with Poland and Finland, Portugal also drops out of this correlation matrix and has more in common with Denmark than with Spain, its only neighbour. This can be explained by the similarity of the legislation of the two countries with regard to euthanasia (where it is considered the same as murder or incitement to suicide, with the “culprits” being held criminally responsible, while in Spain euthanasia was not legally prosecuted at the time the data was collected, and has been completely legal since 2021). We can also observe similarities in the policies of the post-Soviet bloc of countries on this issue. There is also a clear connection between two North American neighbours — the United States and Canada.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Industry	0.036	0.019	0.260	1.890
2	Conservation areas	0.040	0.011	0.250	1.578
3	Ethnic minorities	0.047	0.007	–0.255	1.381
4	Cultural solidarity	0.031	0.036	0.203	1.331
5	Unused export potential	0.076	0.000	0.312	1.286
6	Export	0.124	0.000	0.382	1.181
7	Services sector	0.047	0.009	0.231	1.140
8	IMF voting power	0.086	0.000	0.311	1.121
9	Light pollution	0.038	0.015	0.206	1.117
10	Import	0.115	0.000	0.355	1.099

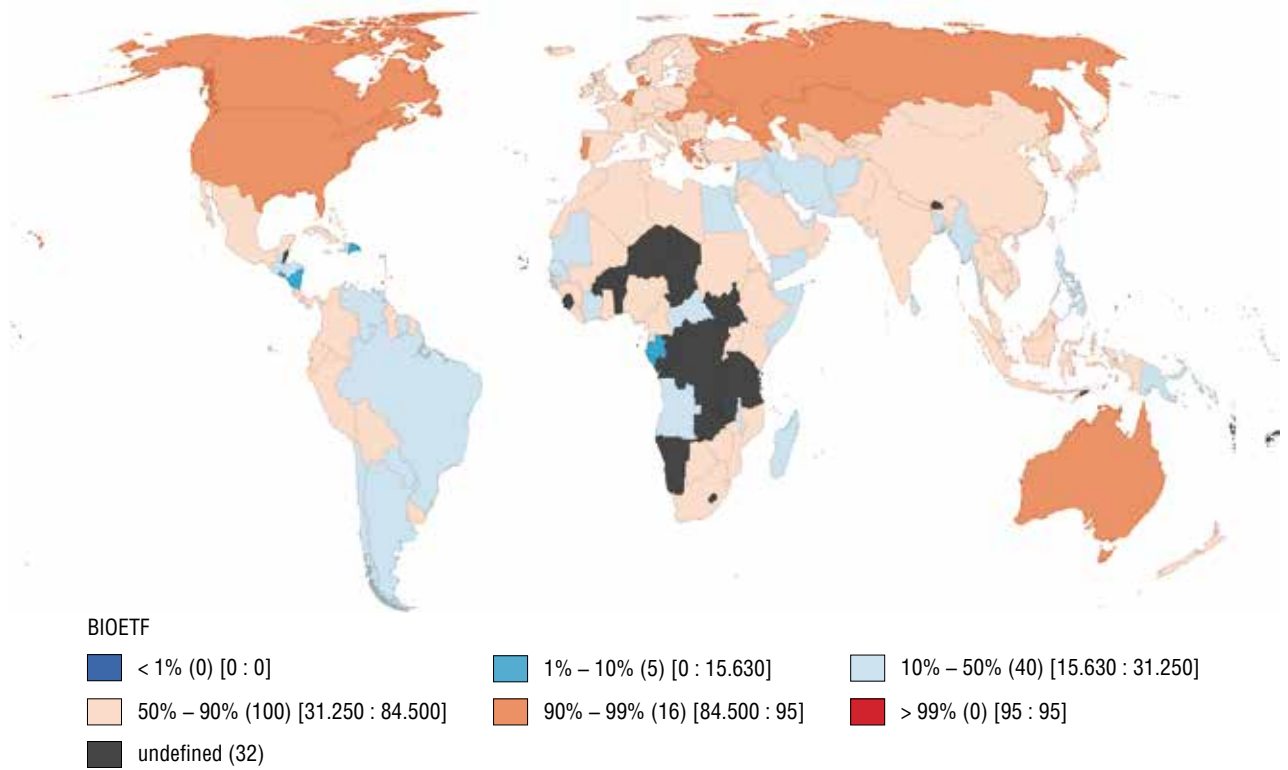


Fig. 9.7.1. Percentile cartogram for the “Bioethical freedom” indicator

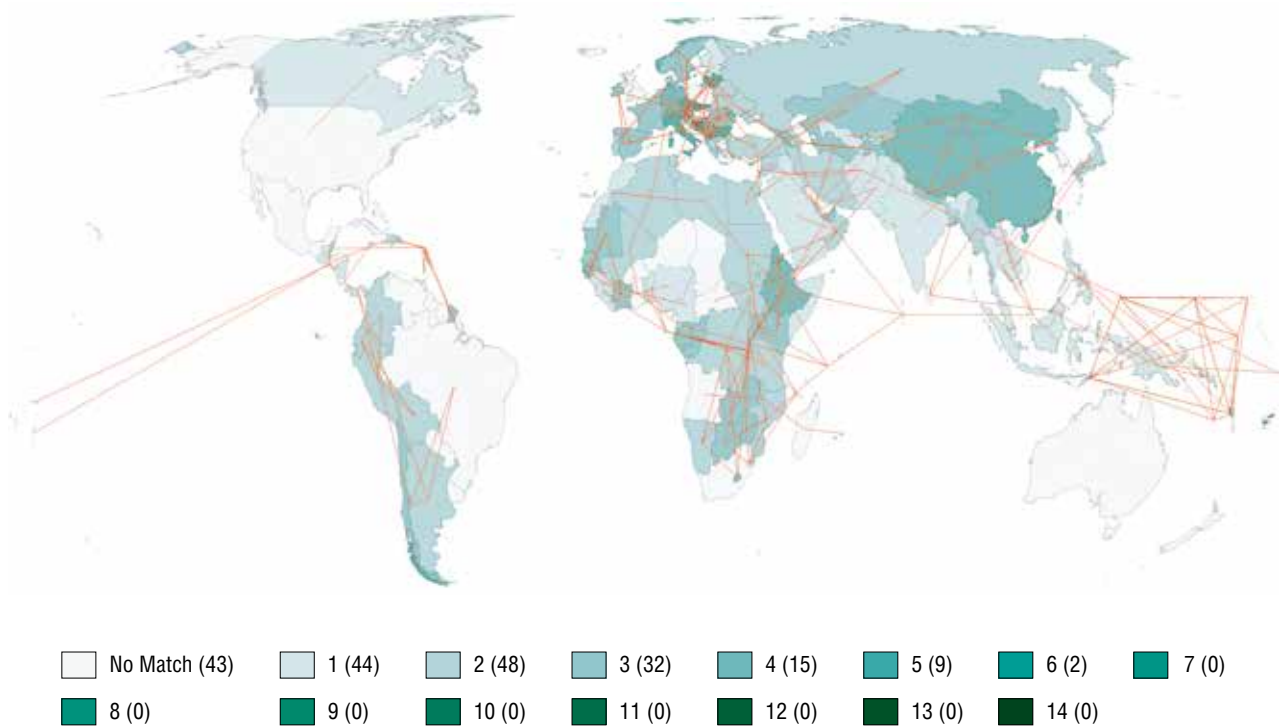


Fig. 9.7.2. Likelihood-ratio test for the “Bioethical freedom” indicator

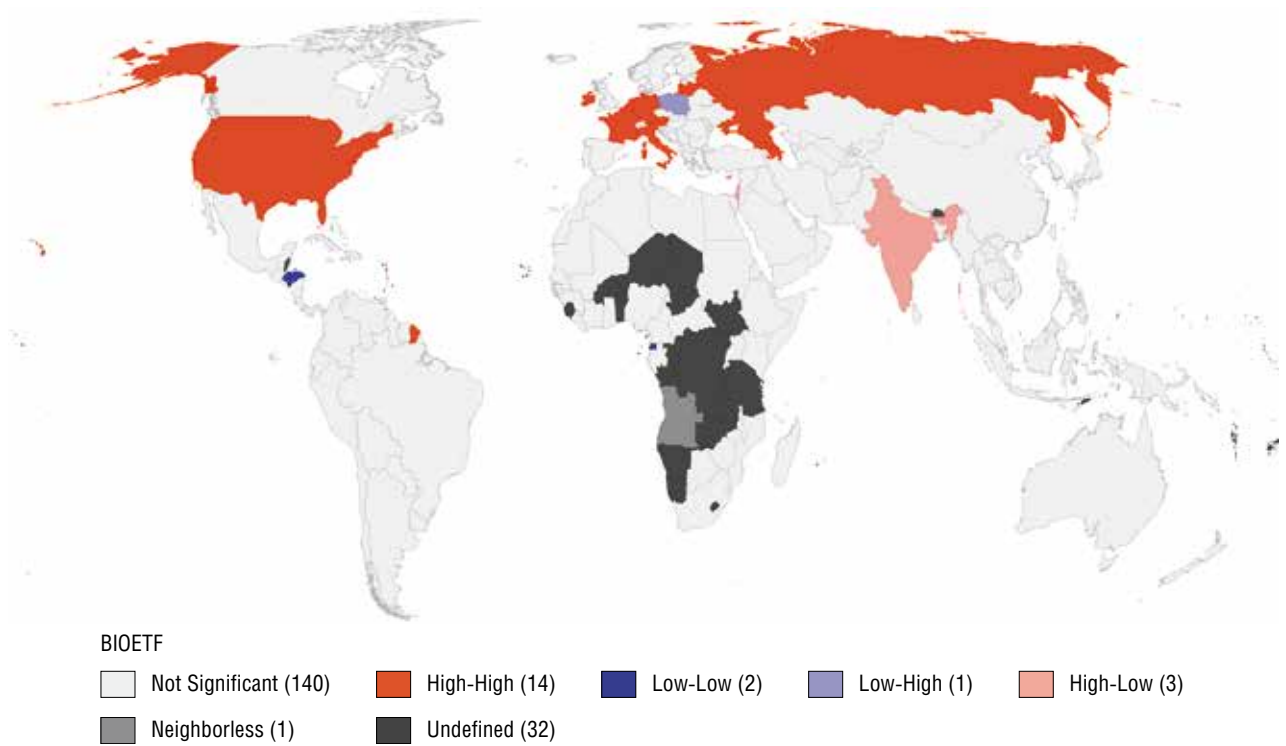


Fig. 9.7.3. “Bioethical freedom” spatial autocorrelation cartogram for the geometric neighbourhood matrix

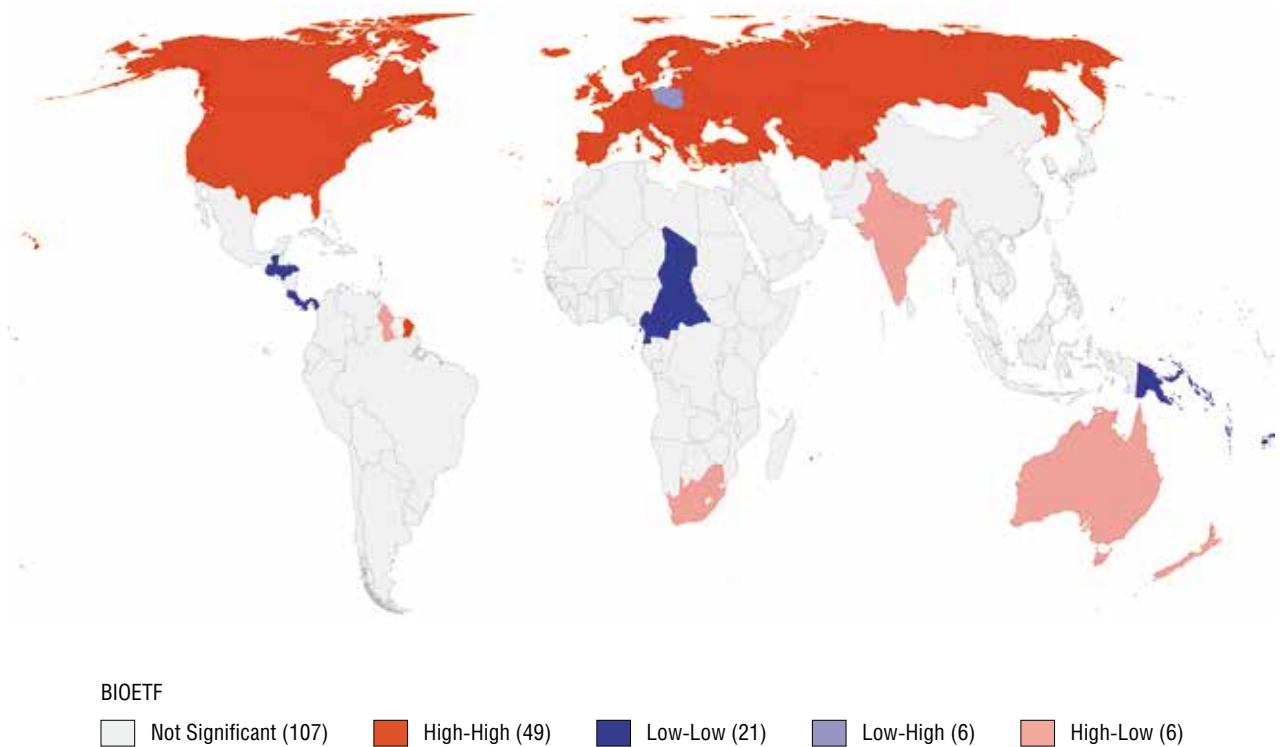


Fig. 9.7.4. “Bioethical freedom” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.8. Film industry

The number of films released by a country is seen as an indicator of so-called “soft power,” and also indirectly serves as a way to determine the ability of the state and/or its population to invest in the development of the tertiary sector of the economy.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.104	0.000	0.027	0.027
Geary's C	0.811	0.147	0.968	0.027

As the percentile cartogram (Fig. 9.8.1) shows, the United States is the undisputed leader in this area, producing films for general release, as well as projects specially for streaming services such as Netflix, Amazon Prime, Hulu, etc. The entertainment industry in the United States has traditionally been geared towards both domestic and international audiences. The same can be said of the United Kingdom. What is more, joint U.S.–UK productions are not uncommon, especially when it comes to the production of series for television or streaming. The situation is slightly different in the top three European countries, France, Germany and Spain, as well as in Canada. In these countries, greater emphasis is placed on independent films that are not necessary for mass consumption. We can thus argue that greater importance is attached in these countries to the development of cinema as an aesthetic component and a way to drive the economy than to its distribution as an element of influence.

A different situation is observed in China and India, where films and series are primarily intended for the domestic audience, and this serves as an effective tool for promoting national culture and developing the tertiary sector, but has little impact in terms of geopolitical influence. In the case of Russia, the number of films has grown largely thanks to the financial support of the Federal Fund for Economic and Social Support of Russian Cinematography (Cinema Fund). The policy is to support films that are “in line with national interests” and to “popularize national films in the Russian Federation and internationally,” which is a significant element of the number of films as an indicator of development.

The Moran's I geometric neighbourhood matrix (Geary's C is insignificant for the geometric matrix) yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed

Global place	Country	Indicator (total number)
1	United States	1711
2	United Kingdom	353
3	China	278
Mean (19)	(Mexico)	53.317 (53)
Median (51–54)	Greece, Serbia, Pakistan, UAE	7
66–71	Albania, Armenia, Afghanistan, Vietnam, Malaysia, Singapore	3
72–84	13 countries	2
85–101	17 countries	1

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.8.3) allows us to identify the main clusters of countries in terms of film production, as well as groups where there is little such activity. Thus, the groups we mentioned earlier — the United States, Canada, France, Germany and Spain — stand out on the geopolitical matrix. The Benelux countries and Italy can be added to this group thanks to their film production, while the number of productions coming out of the countries that form the cluster of Eastern Europe and the Balkans, Scandinavia and North Africa is relatively low. While African countries face serious socioeconomic problems and the population is more concerned about basic economic wellbeing, and the Balkan states have not yet fully recovered from the relatively recent crisis, the countries of Eastern Europe and Scandinavia are avid consumers of content produced in other countries and demand for domestic films is low.

Turkey stands out in its bloc for the large number of films produced. The Turkish film industry is an important part of the national culture and has been actively developing since the laws on the development of the motion picture business were passed in the 1930s. Turkish film studios are actively developing joint productions with film studios from other countries, especially those in the West. A cluster of countries with low indicator values can be identified in North Africa. Despite the high levels of industrialization compared to other parts of the continent, the economies of these countries do not rely on the development of the tertiary sector, and neither the countries themselves nor private companies invest in the film industry. The lack of infrastructure means that there is no commercial benefit to developing the film industry, and methods of cultural influence are not in strong demand in a predominantly Muslim and relatively consolidated society.

The likelihood-ratio test for the geometric neighbourhood and “Film industry” parameter (Fig. 9.8.2) highlights how film production in India stands out from its neighbours, as well as the similarly high level of film production in European countries. The connections in Latin America and Africa are not considered for analysis due to the lack of data for these countries.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Bioethical freedom	0.054	0.021	0.168	0.524
2	Quality of school education	0.043	0.043	0.143	0.476
3	Years at school	0.044	0.037	0.113	0.293
4	Passport power	0.041	0.043	0.105	0.271
5	GDP (PPP) per capita	0.045	0.034	0.096	0.203
6	CO ₂ emissions	0.043	0.039	0.087	0.174
7	Medium- and hi-tech sectors	0.061	0.014	0.072	0.085
8	Tertiary education enrolment	0.052	0.029	0.066	0.084
9	Antiretroviral therapy	0.142	0.003	0.102	0.074
10	Inbound tourism	0.364	0.000	0.153	0.064

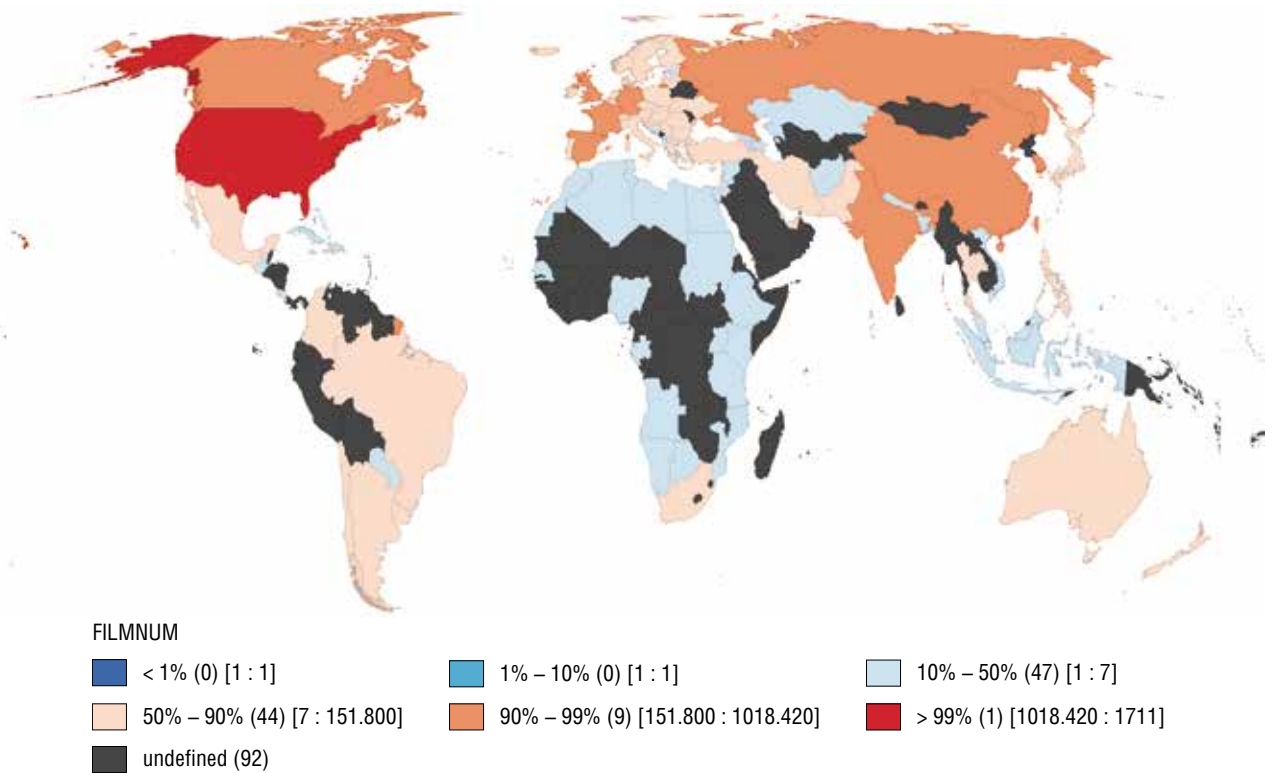


Fig. 9.8.1. Percentile cartogram for the “Film industry” indicator

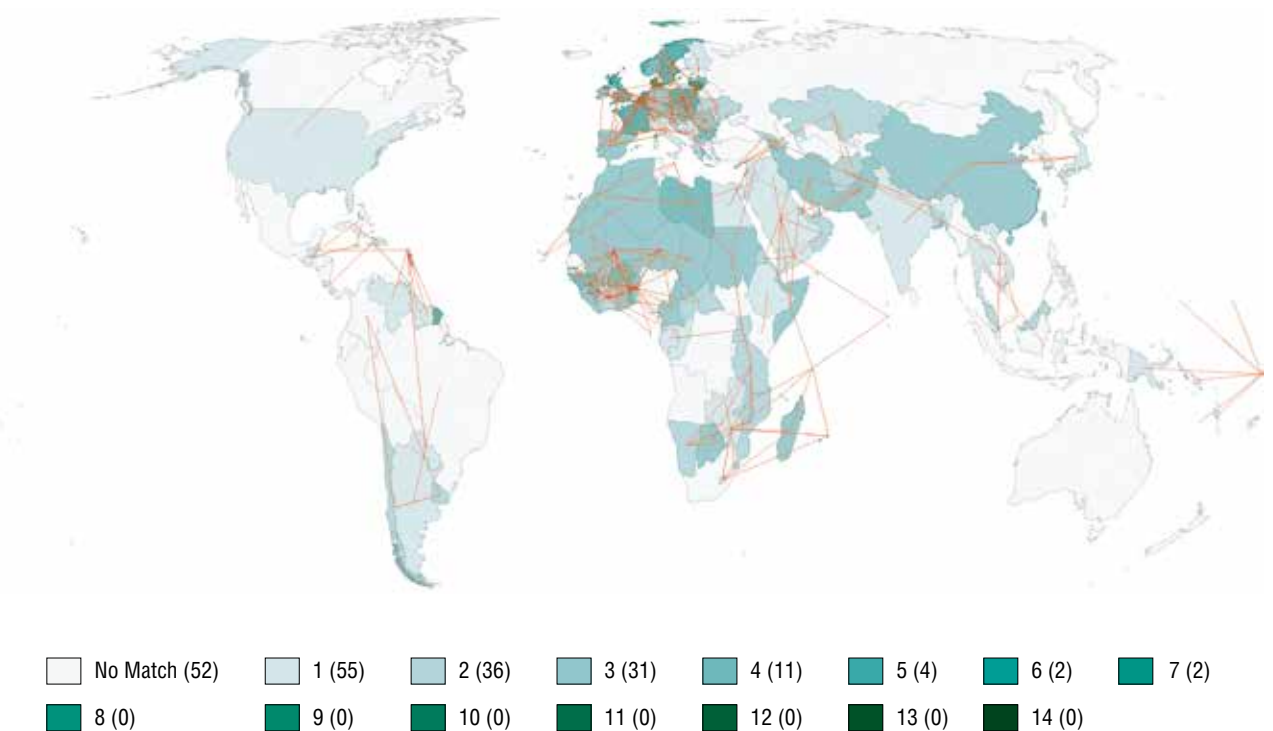


Fig. 9.8.2. Likelihood-ratio test for the “Film industry” parameter

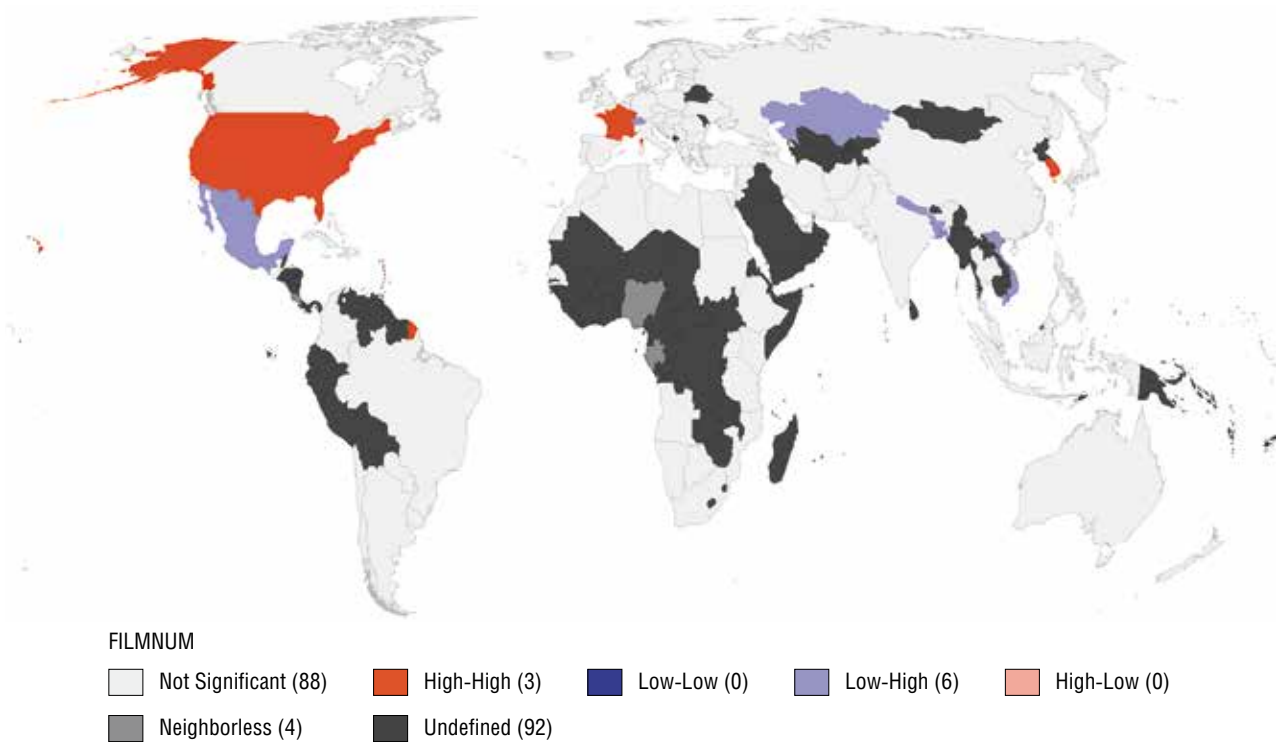


Fig. 9.8.3. “Film industry” spatial autocorrelation cartogram for the geometric neighbourhood matrix

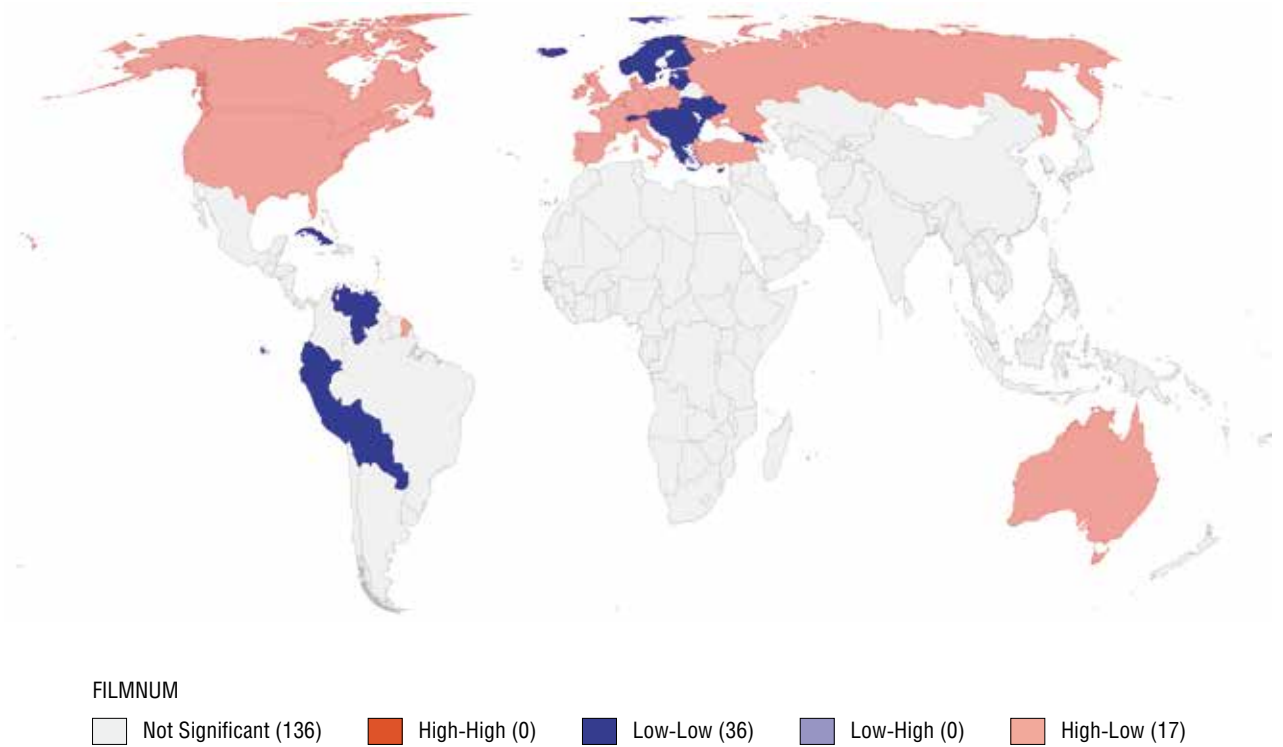


Fig. 9.8.4. “Film industry” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.9. Literacy

The adult literacy rate remains the basic benchmark for assessing and comparing the cultural development of countries and, consequently, improving the quality of other areas of life and promoting economic development.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.322	0.000	0.138	0.000
Geary's C	0.671	0.000	0.857	0.000

According to the percentile cartogram (Fig. 9.9.1), the lowest level of literacy is observed in African countries, which points to poor levels of basic education. A good basic education system opens the door to further training and skills development and, thus, more demanding professional activities and the development of society as a whole. Low adult literacy is also observed in the countries of South Asia and the neighbouring states of the Middle East, where effective policies on education and literacy are difficult to implement due to an unstable political environment or, as in the case of India, for example, a gender gap (men are far more educated than women), as well as the fact that a high proportion of the population is employed in traditional sectors of the economy, where the ability to read and write is not important and is therefore not regarded by the population as a requirement for finding a job — despite the efforts of government campaigns.

A similar situation is observed in the countries of Central America. We should note here that figures were not provided for Canada, the United States and most countries in Europe, since the data was collected as part of human development reports, mainly for countries with emerging economies.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical neighbourhood matrix, and the hypothesis that the world's geopolitical structure has greater significance for adult literacy is thus not confirmed.

Global place	Country	Indicator (%)
1	Uzbekistan	100
2–3	Latvia, San Marino	99.9
4–6	Azerbaijan, Belarus, Kazakhstan	99.8
Median (60)	(Bolivia)	92.65 (92.5)
Mean (73–74)	(Gabon, Laos)	83.9980 (84.7)
116	Mali	35.5
117	South Sudan	34.5
118	Chad	22.3

A cluster of post-Soviet countries with high literacy levels can be identified on the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 9.9.3). This is arguably thanks in large part to the Soviet policy to eliminate literacy throughout the country, especially in rural areas. A significant cluster of West African countries is also emerging in which the adult literacy rate is below the average for sub-Saharan Africa (one reason for this is the lack of access to education and the high levels of corruption in this region, even compared to other African countries).

The cartogram for the geopolitical neighbourhood matrix (Fig. 9.9.4) clearly shows a cluster of states that form a CIS/CSTO/EAEU bloc and reflect the high literacy levels of the post-Soviet countries, as well as the states of West Africa mentioned in the previous paragraph that are members of the Economic Community of West African States (ECOWAS). Despite the fact that one of the declared goals of ECOWAS is to improve quality and accessibility of education, data shows that illiteracy is still an issue in these countries.

The likelihood-ratio test for the “Literacy” indicator (Fig. 9.9.2) highlights the contrast between the countries of the post-Soviet space, on the one hand, and South Asia, on the other. There is no correspondence here, as the literacy level of the latter is, as we have noted, far lower. There is, however, a correlation in the cluster of countries of Central and Latin America, as well as the bloc of West African states. The correlation for European countries is not statistically significant in this case due to the gaps in the data.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Light pollution	0.036	0.041	0.218	1.310
2	IMF voting power	0.042	0.026	0.200	0.950
3	Cultural solidarity	0.103	0.001	0.278	0.752
4	Publication activity	0.141	0.000	0.324	0.745
5	Passport power	0.355	0.000	0.496	0.693
6	Population growth	0.244	0.000	-0.395	0.640
7	Regional trade agreements	0.139	0.000	0.294	0.620
8	Elderly population	0.211	0.000	0.361	0.618
9	Particulate air pollution	0.323	0.000	-0.443	0.608
10	CO ₂ emissions	0.147	0.000	0.295	0.593

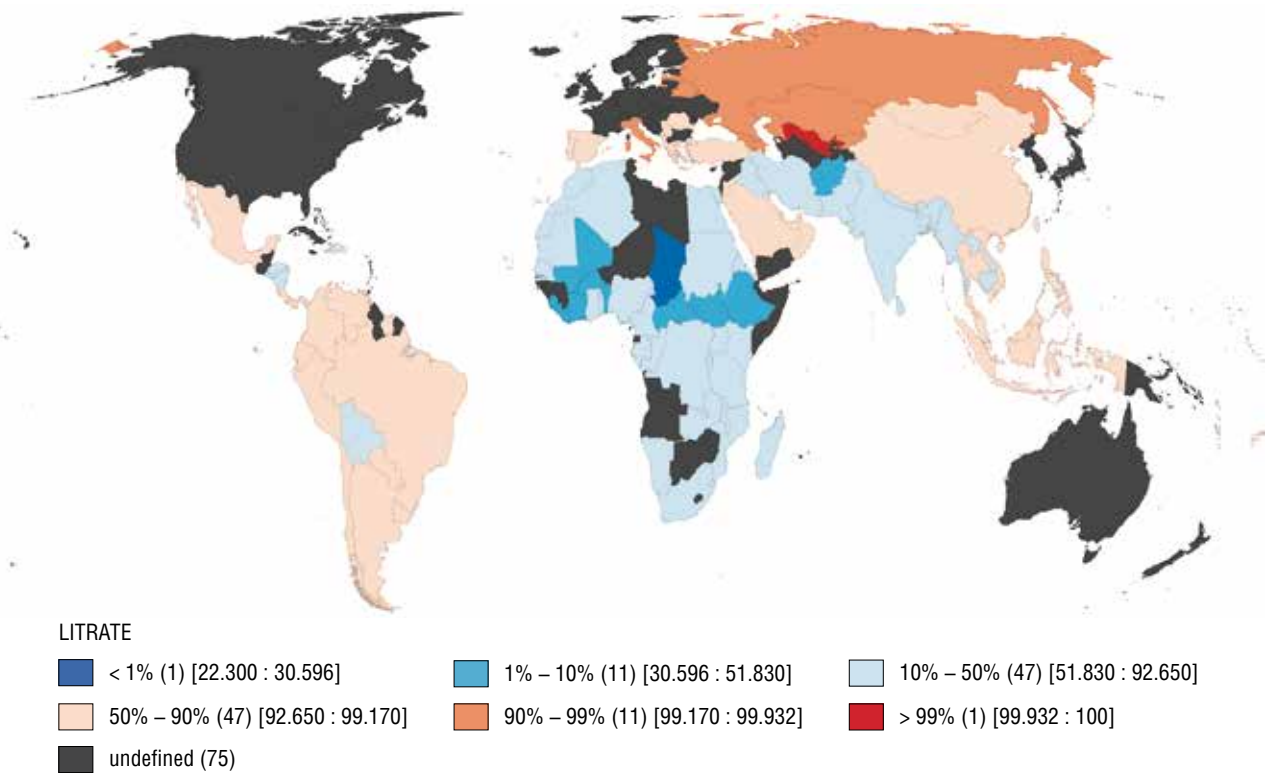


Fig. 9.9.1. Percentile cartogram for the “Literacy” indicator

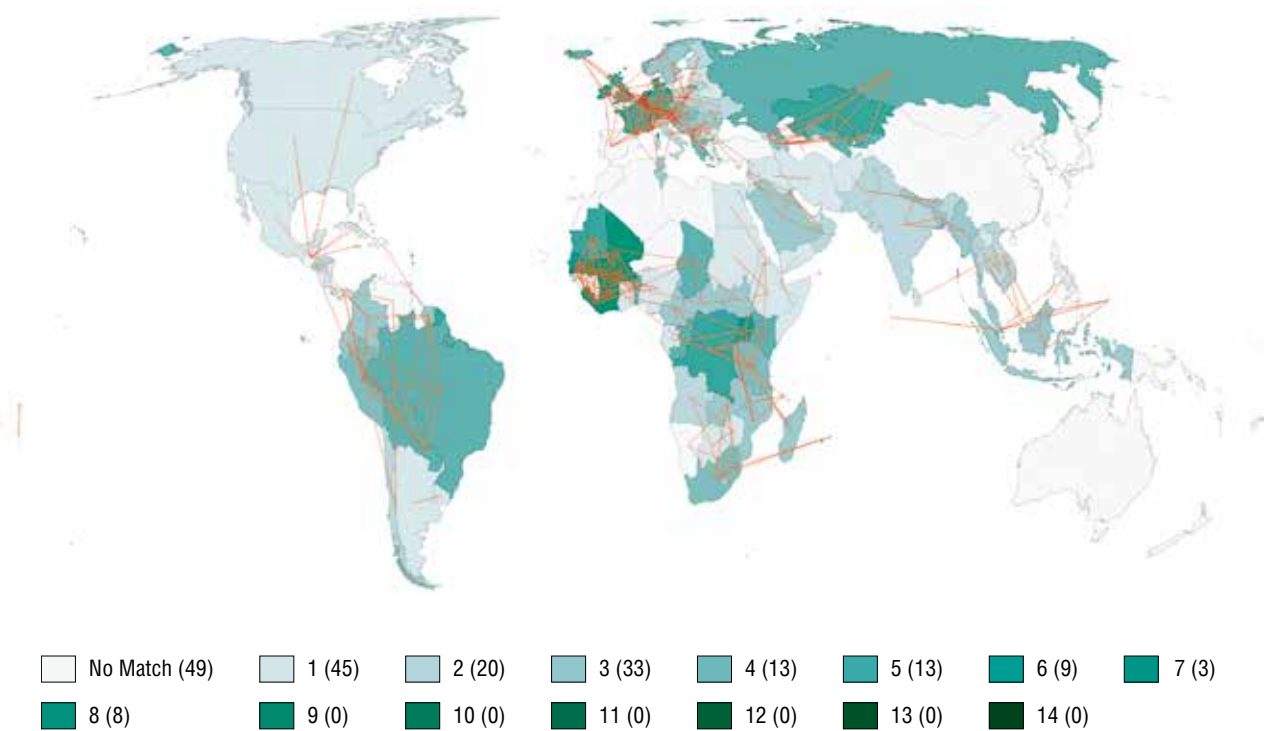


Fig. 9.9.2. Likelihood-ratio test for the “Literacy” indicator

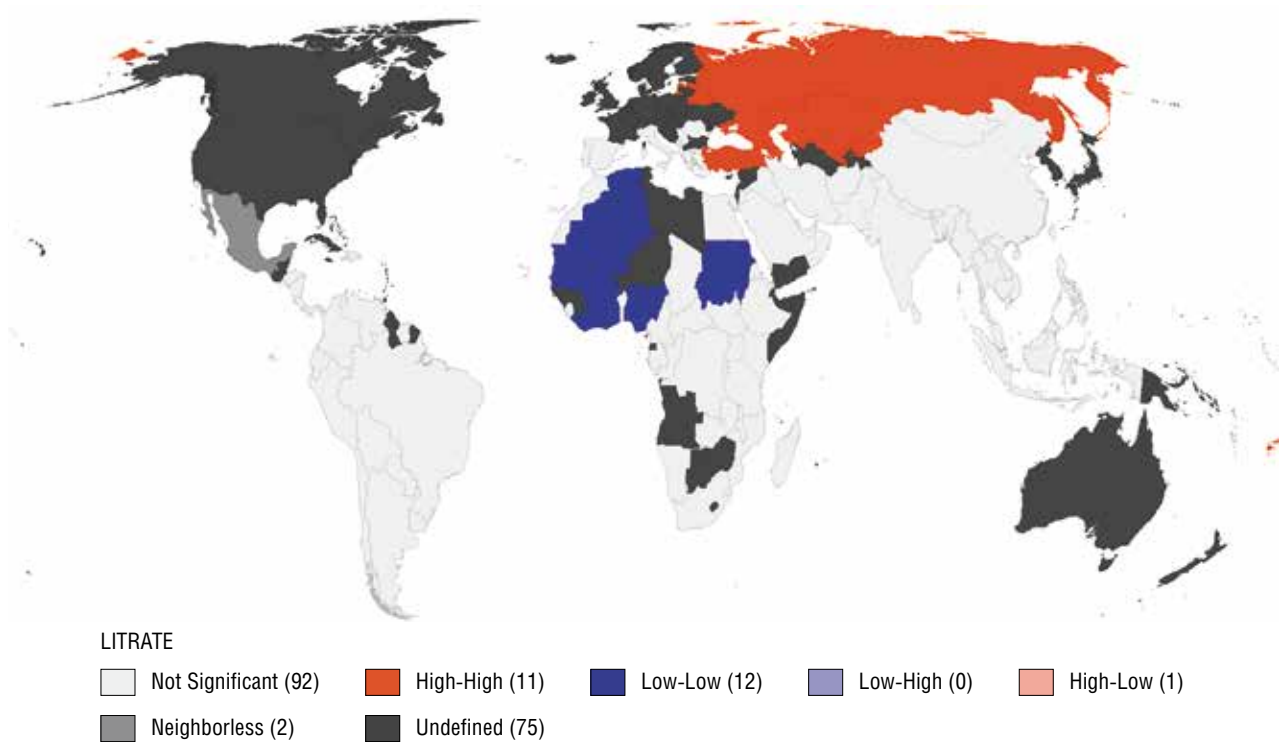


Fig. 9.9.3. “Literacy” spatial autocorrelation cartogram for the geometric neighbourhood matrix

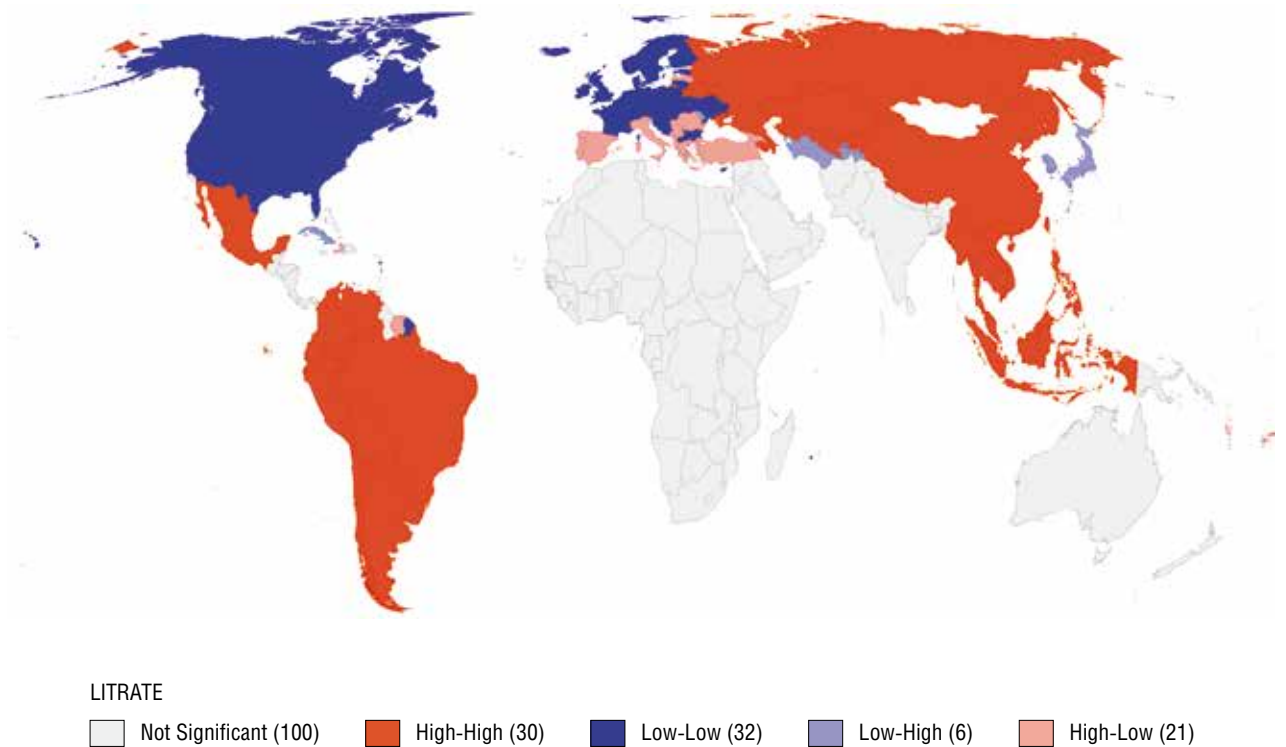


Fig. 9.9.4. “Literacy” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.10. Number of libraries

The overall development of a country is inextricably linked with an increase in human capital. For this to happen, the population needs access to information and technologies, as well as places to exchange experience and acquire new knowledge. This is typically achieved through libraries of various levels and specializations.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.397	0.000	0.231	0.000
Geary's C	0.604	0.000	0.765	0.000

Looking at the percentile cartogram for the number of libraries per 1 million population (Fig. 9.10.1), India immediately catches the eye. India's high score for this indicator is most likely thanks to the state policy to increase the role of libraries as centres of information, education and self-learning with the promotion of digital libraries to address the imbalance between the country's dynamic economy and its relatively poor sociocultural development. There is also a high concentration of libraries in Eastern European countries: in the former Czechoslovakia, for example, a law was introduced when the country ceded from the German-speaking Austria-Hungary on the creation of a vast network of public libraries to ensure the cultural and linguistic development of the new country. The creation of libraries was also overseen by the central authorities of the former Soviet Union and the countries of the communist camp, and this legacy of the 20th century continues today, especially where they have been modernized and serve as digital centres and public spaces.

However, we should be mindful of the fact that this indicator is relative, due to population size. For example, Bhutan, which has a population of less than 1 million, is among the leaders thanks to the large number of school libraries relative to the number of citizens. Meanwhile, China, which has a high total number of libraries but a population of over 1 billion people, is at the level of the countries of Africa, where, unsurprisingly, there are few libraries due to the low level of literacy. The low figures for some European countries can presumably be attributed to the specific features of the countries in question: libraries in Italy, for example, emphasize the conservation of the existing cultural heritage more than simply opening

Global place	Country	Indicator (number per 1 million population)
1	India	1118.0
2	Czech Republic	999.6
3	Bhutan	953.8
Mean (51)	(South Korea)	287.85 (271.9)
Median (61)	(Bahrain)	197.3 (191.7)
118	Yemen	0.4
119	Papua New Guinea	0.3
120	Burundi	0.1

new libraries in new locations. We can also assume that it depends on the number of universities, research centres and other infrastructures that have their own libraries — this is a common feature among the countries of the Anglo-Saxon world, for example.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix reflects the similarity we have already seen on the percentile cartogram for the high-value cluster of Eastern European countries that also includes Russia. Note that data is not available for all African countries, and the data that we do have indicates that there are not many libraries there, which is not unexpected.

A cluster of “errors” is apparent on the cartogram for the geopolitical neighbourhood matrix — countries centred around Germany and a number of Scandinavian states, where the concentration of libraries is lower than in neighbouring Eastern Europe. Given the rich cultural heritage and generally high level of education in these countries, this phenomenon can be explained by the fact that the population prefers to use the centralized online portals of the national and other large libraries, which reduces the demand for physical branches, even if the existing spaces are suitably equipped for the purpose. Thus, a low number of libraries does not necessarily indicate a low level of development, but, on the contrary, the existence of a unified and convenient hi-tech information system. In addition, the cartogram for the geometric neighbourhood matrix allows us to single out a cluster with a high number of libraries in the bloc of CIS countries (in particular Russia, Belarus and Kazakhstan). This can be attributed to the fact that certain countries in the region are implementing national programmes to preserve their cultural and historical heritage through libraries — Kazakhstan, for instance, has its *Mädeni mura* programme. Meanwhile, Kyrgyzstan is separated from the cluster on account of its lower score on this indicator. We can assume that this is because of most of the educational and cultural centres in the country are based in the capital region: Bishkek and other major cities have a decent number of libraries, whereas the rural districts have practically none.

The likelihood-ratio test for the “Number of libraries” indicator again highlights the node of Eastern European countries where the numbers are high, as well as those developed countries where there are relatively few libraries. It also shows the countries of Africa with scores similar to those of Latin American states, which we can see in the percentile cartogram too. At the same time, the policies of the countries of Asia towards libraries appear to differ markedly.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Female population	0.033	0.048	0.214	1.380
2	Elderly population	0.135	0.000	0.352	0.918
3	Regional trade agreements	0.074	0.003	0.256	0.882
4	Tertiary education enrolment	0.099	0.001	0.295	0.881
5	Alcoholism	0.057	0.008	0.224	0.876
6	Population growth	0.235	0.000	-0.427	0.777
7	Economic inequality	0.101	0.001	-0.277	0.758
8	Maternal mortality	0.122	0.000	-0.303	0.753
9	Highly wealthy population	0.142	0.000	-0.322	0.729
10	Number of doctors	0.086	0.001	0.241	0.672

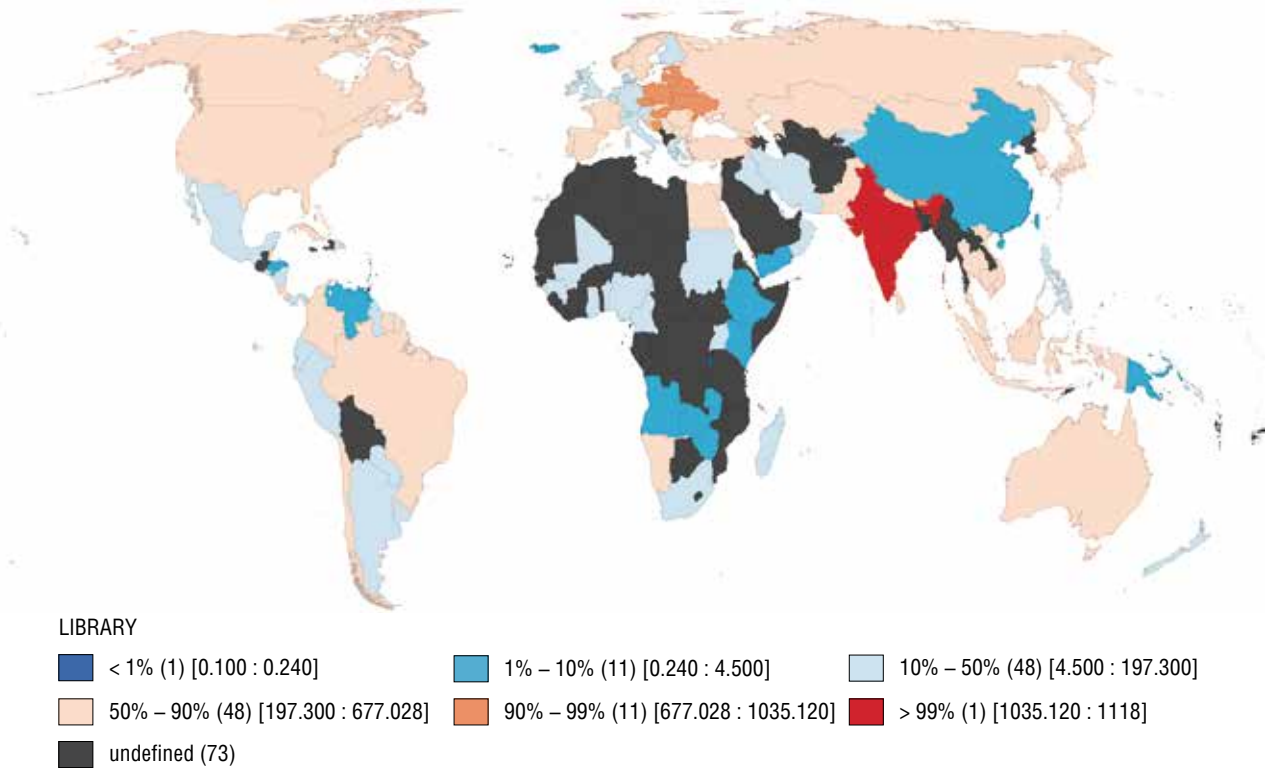


Fig. 9.10.1. Percentile cartogram for the “Number of libraries” indicator

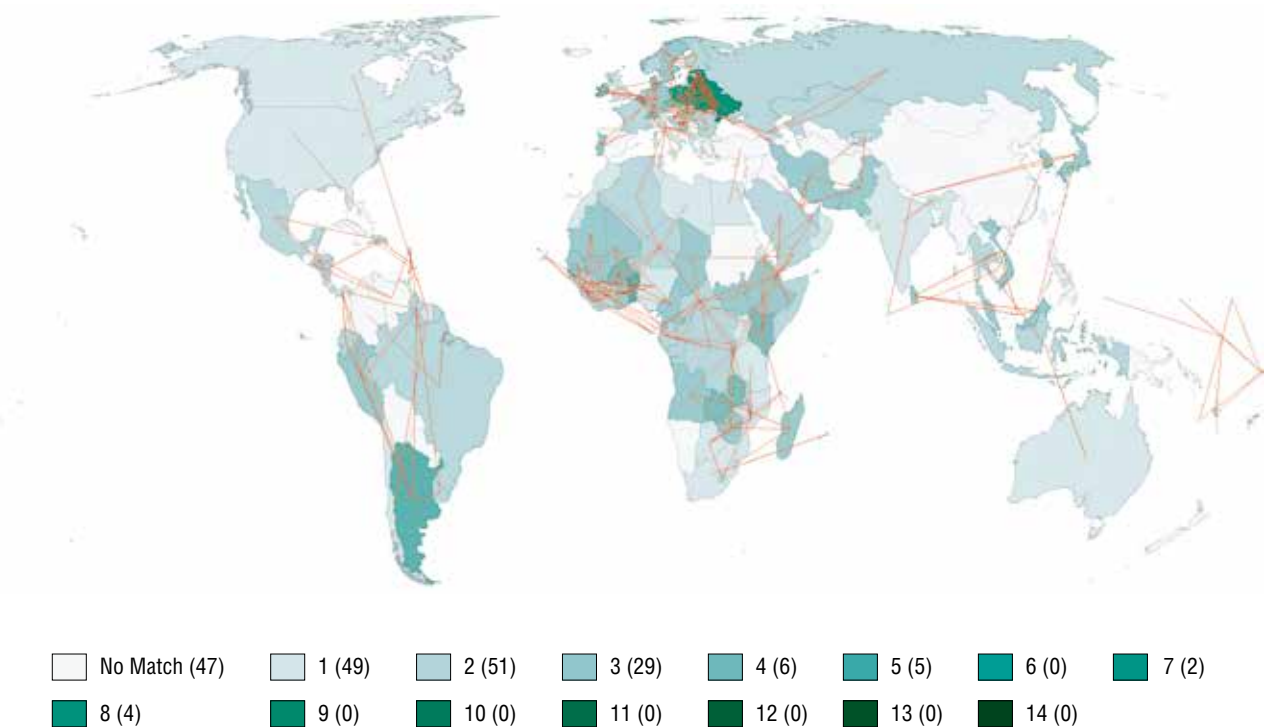


Fig. 9.10.2. Likelihood-ratio test for the “Number of libraries” indicator

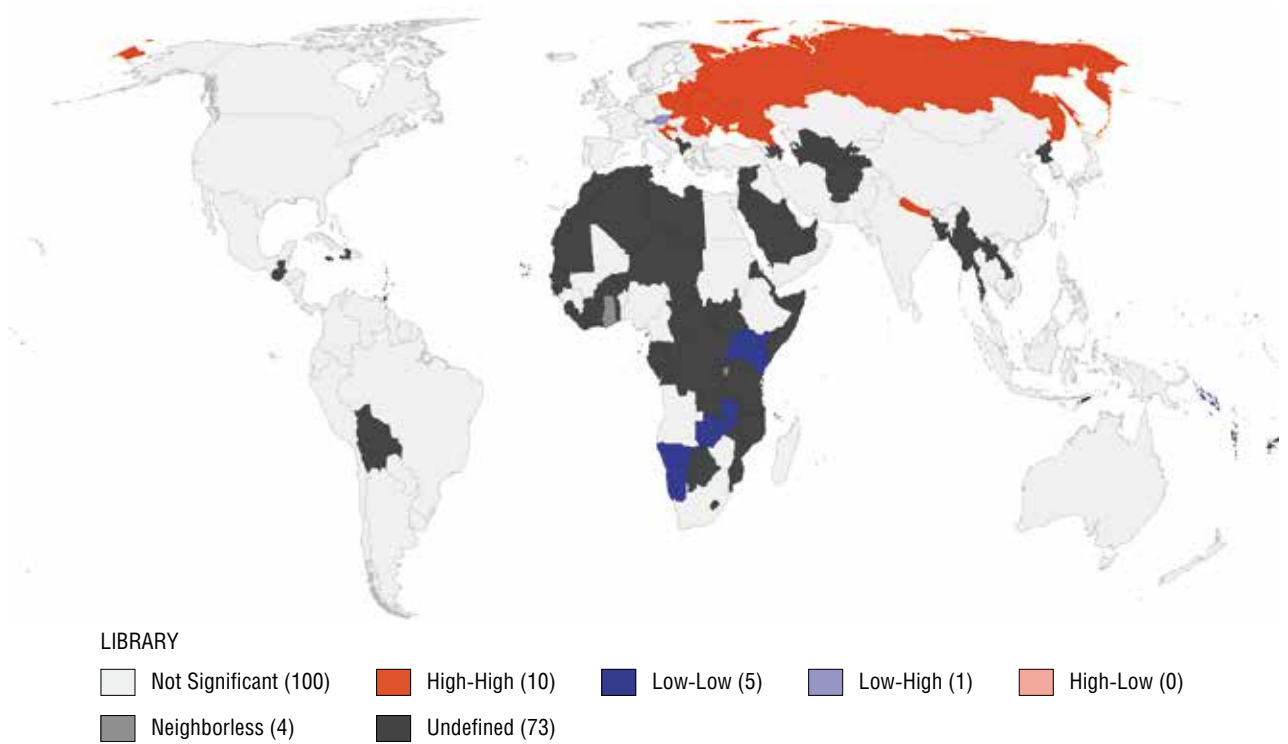


Fig. 9.10.3. "Number of libraries" spatial autocorrelation cartogram for the geometric neighbourhood matrix

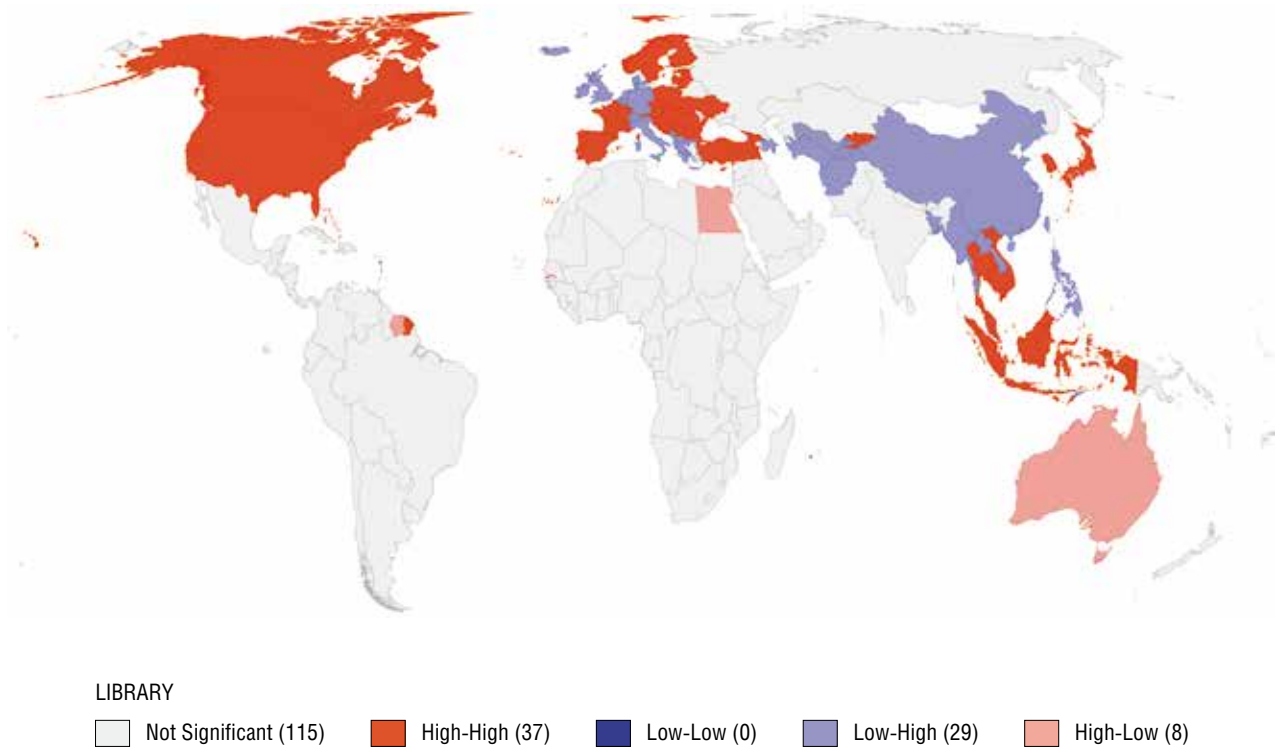


Fig. 9.10.4. "Number of libraries" spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

9.11. Multifactor analysis of the “Culture” section indicators

The next logical step is to analyse the entire group of indicators as a whole.

We will start with the geographic average. There is a significant divergence in the “Culture” section indicators between such metrics as adult literacy, the number of libraries per 1 million people, and the number of films released by the country.

The number of libraries serves as an indicator with a fairly standard distribution of values around the world. At the same time, the ellipse for the number of films is strongly elongated to the north-west, a result of the fact that the United States is the main producer of this type of cultural product by a wide margin. The geographic average for literacy is skewed to the south-west and north-east due to the fact that the countries of Central Europe were almost not taken into account, since the data was collected for the purposes of monitoring human development indicators primarily in countries with emerging economies. The ellipse thus tends in the way we have described as a result of the higher literacy rates in Latin America compared to African countries, on the one hand, and of the high literacy rates in Russia and the countries of Central Asia, on the other.

The biggest discrepancy among the “Culture” section indicators by geopolitical bloc is observed between ethnic fractionalization and cultural cohesion, which is logical given the actual opposition of these indicators. In Latin America, for example, the “cultural cohesion” indicator stretches from north-west to south-west, which is due to the relative confessional (Catholic) and linguistic (Spanish) homogeneity of the countries that make up this group. The “ethnic fractionalization” ellipse is most elongated in Europe, the Middle East and North Africa: the ethnic heterogeneity of European states is beyond doubt, while the results for the Maghreb and Mashriq regions can be explained by the fact that the Arab ethnic grouping in the initial base can be broken down into smaller subgroups (Egyptian Arabs, Saudi Arabs, etc.). A certain divergence is observed in the group of states of Southeast Asia: the “ethnic fractionalization” ellipse is elongated from north to south and does not include China, which is relatively ethnically homogenous, or the essentially monoethnic Japan and North and South Korea. The “cultural cohesion” ellipse, however, does include the countries of Indochina and East Asia, which are relatively united linguistically and confessionally, while the Muslim countries of Southeast Asia fall outside it due to their different religious affiliation. Compact and rounded ellipses for both indicators are observed in the countries of Southern Africa, Central Asia and South Asia, which can be explained by the relative confessional and cultural homogeneity, combined with ethnic diversity, in the countries of these regions.

Let us now move on to an analysis of multifactor Geary’s C. Neighbourhood matrices were created based on four indicators from the “Culture” section: number of films, number of libraries, literacy rates and cultural exports. These indicators were chosen because they are unidirectional and indicative when it comes to assessing the importance of the neighbourhood factor in the assumed interdependence between material cultural production, literacy level, and reproduction of cultural heritage. The use of ten indicators from this section produced the results in which the world demonstrated deep cultural interconnectedness (both existing qualitatively and caused by the multidirectional nature of some indicators).

The geometric neighbourhood matrix (Fig. 9.11.1) allows us to identify four clusters of countries that are closest to each other in this group of indicators. First is a sub-Saharan Africa cluster, where the values for all indicators are low. Brazil and Colombia are also similar, with relatively high scores for the number of libraries and cultural exports. Then there is a cluster of Eastern European countries, the Baltic States, Ukraine and Belarus, based exclusively on the fact that they all have a large number of libraries. Meanwhile, France, the United Kingdom and the Benelux countries form a cluster of states with a high level of cultural exports and film production (the United Kingdom and France are second and fourth in the world, respectively, in terms of the number of films released). The same bloc of Latin American countries (Brazil and Colombia) stands out in the geopolitical neighbourhood matrix. The high levels of ethnic

fractionalization and religious diversity in Africa are what distinguish most of the ECOWAS countries, as well as the cluster of states in West Africa.

The use of inverse spatial cluster analysis for the indicators in this section would give us ambiguous results. The statistical clusters cartogram (Fig. 9.11.3) is not particularly indicative here, since a qualitative analysis of the relative proximity of countries in terms of culture is carried out for indicators that are mostly of a compound, index nature, or have a completely different qualitative context, despite the numbers being the same. This is why it is not appropriate to interpret a collective group of ten cultural indicators in numerical terms. In this case, a cluster analysis only shows us the most common groups of countries in Europe and Latin America, and partly in Southeast Asia.

However, adding the factor of geographic proximity (Fig. 9.11.4) allows us to analyse countries in blocs that have similar cultural backgrounds. Multidimensional scaling revealed states that stood out from their respective geopolitical clusters while taking the factor of geographic proximity into account. In the bloc of Latin American countries, for example, Guatemala and Belize produced qualitatively different results for the indicators in this section than their neighbours. This is likely due to the greater linguistic diversity in these countries (a similar result occurs due to the existence of languages such as Garifuna, Kaqchikel and Yucatec in Guatemala, Belize and Mexico), as well as to the fact that the largest ethnic minorities in these states (the Maya in Guatemala, and Anglo-African Creoles in Belize) account for a greater proportion of the total population than in neighbouring countries, and they are more heterogeneous in terms of their religion (Catholics in both countries make up only 40% or so of the population, which contrasts sharply with the situation in neighbouring states).

What is more, the “Linguistic diversity” indicator makes Suriname and Guyana outliers, as the official languages in these countries are Dutch and English, respectively, and other languages (mostly Creole variants) are used by only a fraction of the population.

Looking at the situation in Europe, the Benelux countries do not fit into the cluster. This is because bioethical freedom (particularly with regard to euthanasia legislation and the use of stem cells) in these states is far higher than in surrounding countries. The same is true of cultural exports.

As for the Balkan Peninsula, adjusted for geographical proximity, Bosnia and Herzegovina and North Macedonia stand out statistically on account of the high religious diversity of these states, where a large number of Muslims live side by side with Orthodox Christians and Catholics. In North Macedonia, the large Albanian population also contributes to the high scores for the “Ethnic minorities” and “Ethnic fractionalization” indicators. The same applies to Bosnia and Herzegovina, where the ethnicization of religious differences has led to a situation in which Serbo-Croatian-speaking Bosniaks, Serbs and Croats are recognized as separate ethnic groups.

Among the states of South Asia, Bangladesh, as well as Nepal and Bhutan, stand out. Bangladesh is one of the few almost completely mono-ethnic states in the world (approximately 98% of the population are Bengalis), which distinguishes from neighbouring states in terms of the “Ethnic fractionalization” and “Ethnic minorities” indicators. Nepal and Bhutan also differ from their neighbours in terms of ethnic heterogeneity. There are fewer numerically significant ethnic groups in these countries, and the largest ethnic minorities (the Chhetri and Nepalese, respectively) in each make up a greater proportion of the population than in neighbouring states. Bangladesh also stood out, presumably due to its lower scores on the linguistic diversity index — despite the fact that a great many languages are spoken in the region, some 98% of the population still use Bengali as their mother tongue.

We should also mention Somalia in East Africa. While there are many sub-ethnic groups in the country, the population makeup is dominated by Somalis (approximately 85%), who speak Somali. This makes for lower ethnic and linguistic fractionalization, a higher proportion of the largest ethnic minority in the country, and greater cultural solidarity than in neighbouring Djibouti, Ethiopia and Kenya.

The results of multidimensional scaling were also interesting (Fig. 9.11.5). Most of the countries of Africa, as well as Indonesia and some countries in the Middle East, are in the lower right quadrant. We

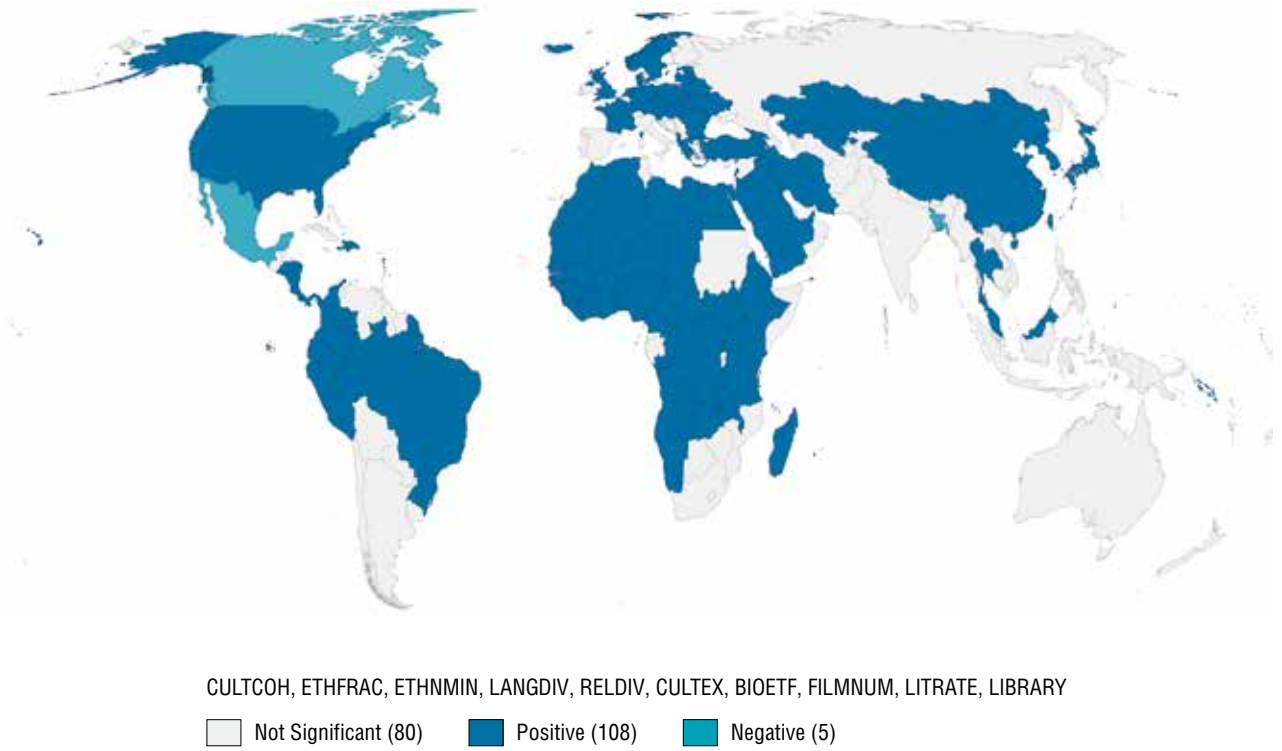


Fig. 9.11.1. “Culture” spatial autocorrelation cartogram for the geometric neighbourhood matrix

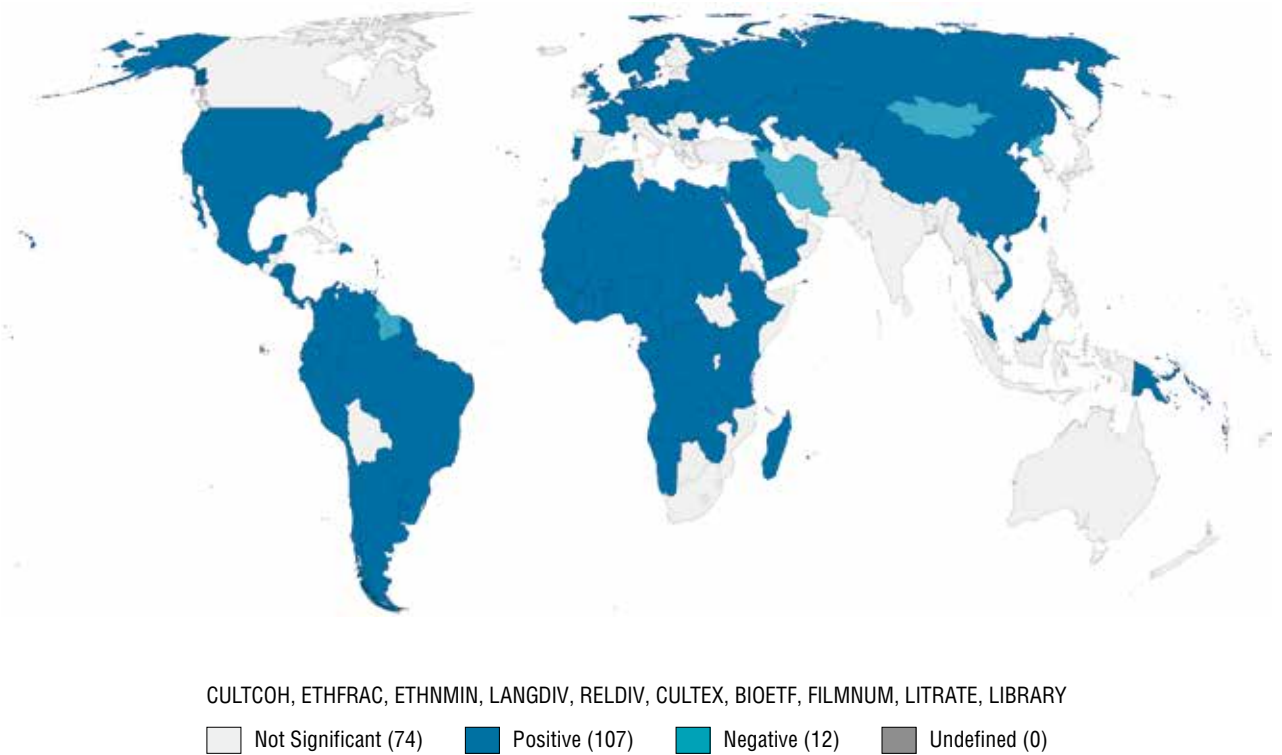


Fig. 9.11.2. “Culture” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

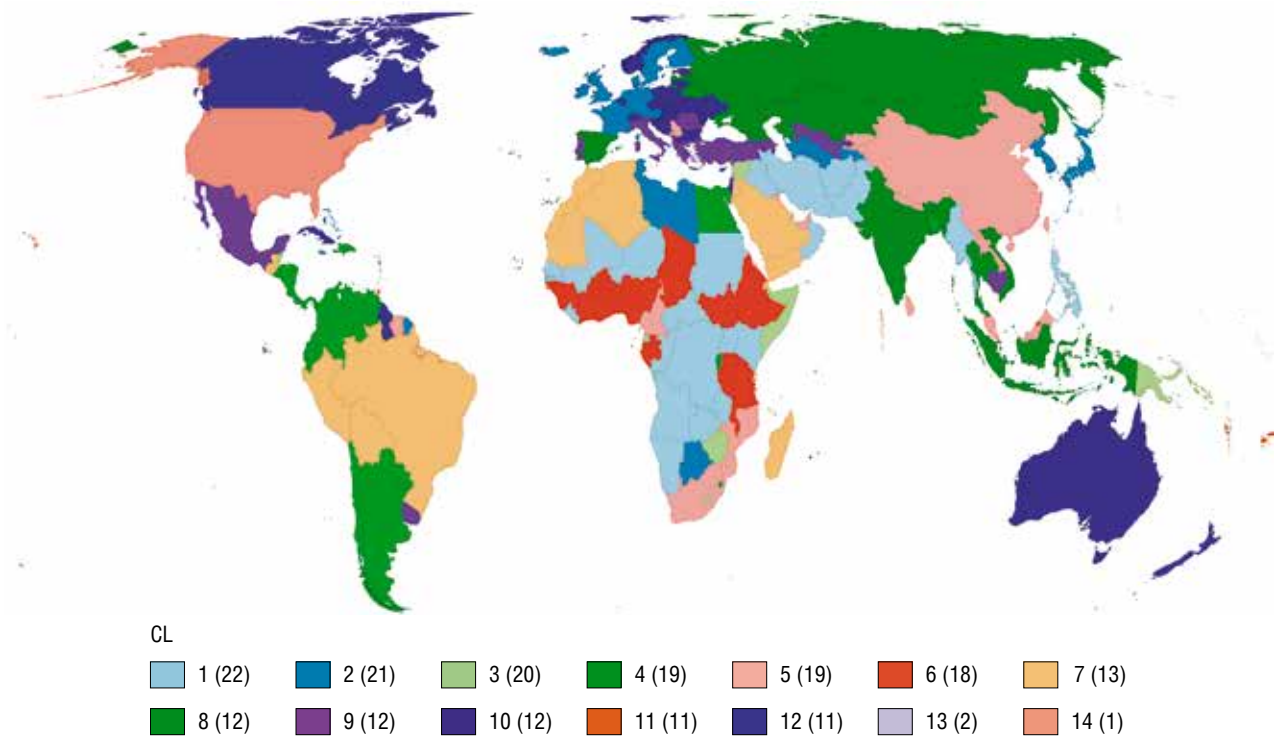


Fig. 9.11.3. Statistical clusters cartogram for the "Culture" section indicators

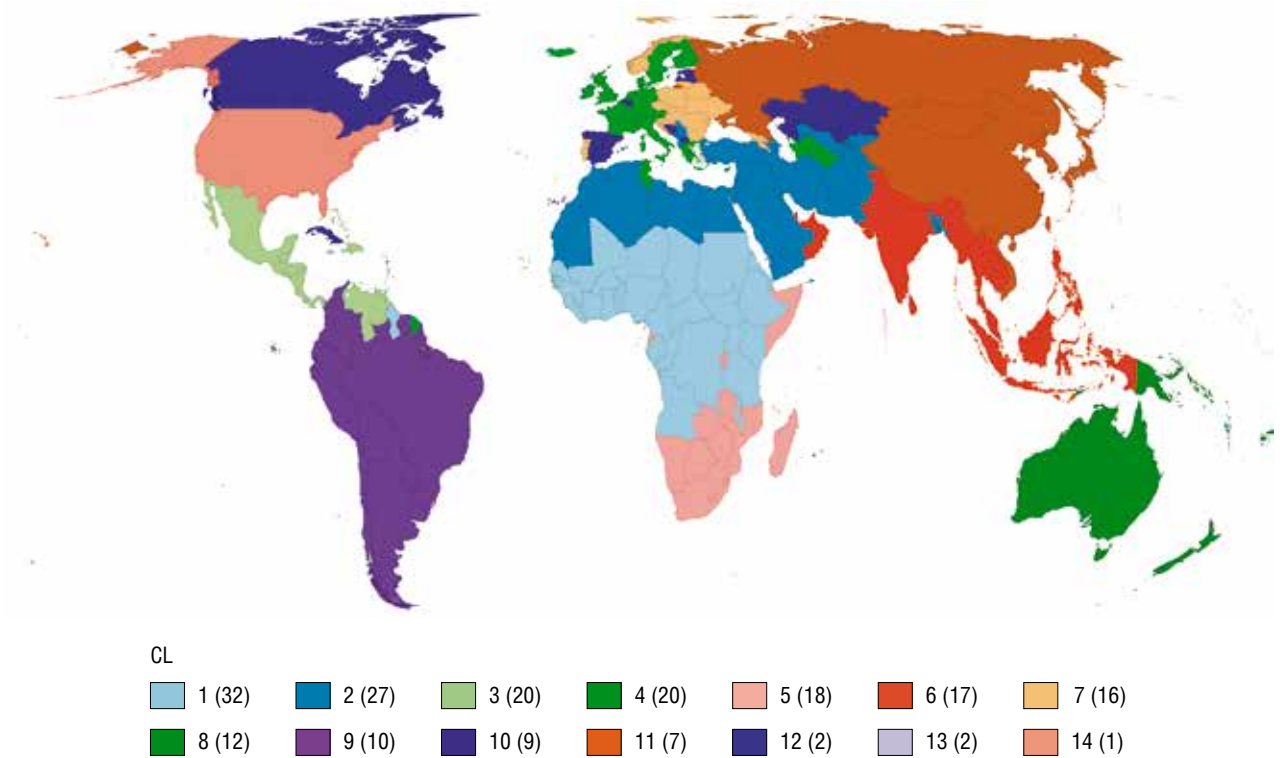
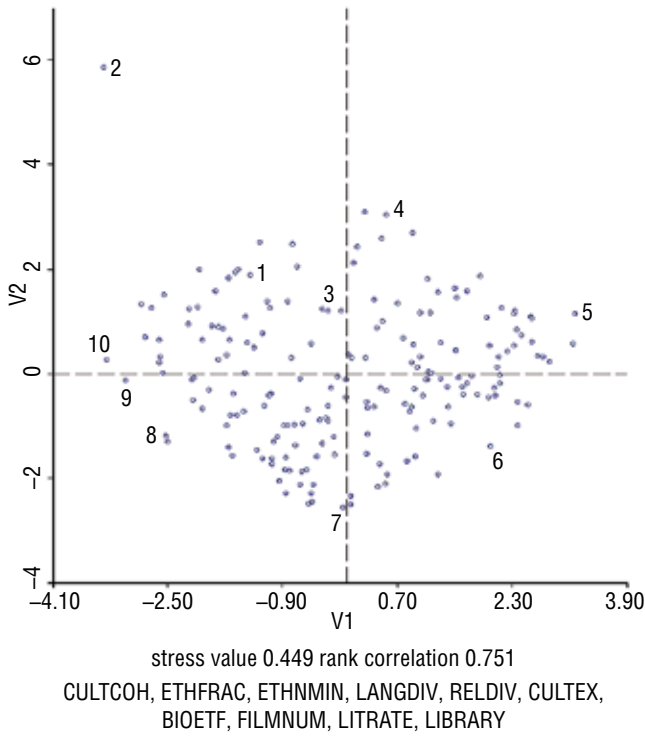


Fig. 9.11.4. Statistical clusters cartogram for the "Culture" section indicators adjusted for geographic proximity



1	Russia
2	United States
3	China
4	Bosnia and Herzegovina
5	Togo
6	East Timor
7	Samoa
8	Iceland
9	Poland
10	Armenia

Fig. 9.11.5. Multidimensional scaling chart for the “Culture” section indicators

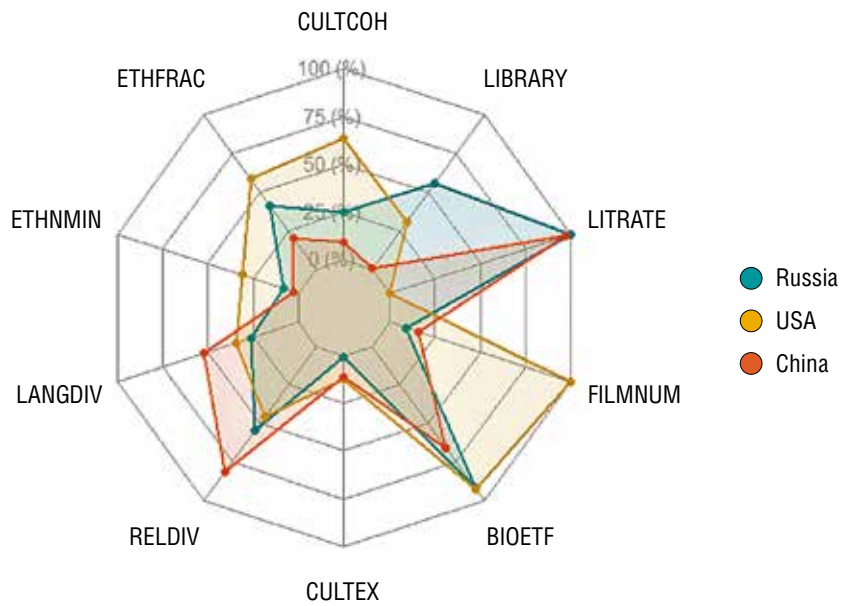


Fig. 9.11.6. Radar chart for the “Culture” section indicators

can thus assume that this quadrant contains countries that have a high degree of linguistic diversity and low literacy levels. In the lower left quadrant, we can see the countries of Latin America and Central Asia, as well as Egypt, Libya, and the microstates of the Asia-Pacific region. The upper left quadrant primarily contains the most developed countries, as well as most of the BRICS grouping (Russia, China and India), the states of Central Europe, Japan and South Korea. These countries produced the highest scores in cultural exports, films, and bioethical freedom. The upper right quadrant is occupied by such countries as Canada, Brazil, and some African and Southeast Asian countries. This is the most heterogenous sector, where countries are most likely to be grouped according to the similarity of various indicators. The biggest outlier here is the United States, which is several orders of magnitude ahead of everyone else in terms of the number of films produced. Poland stands out from the other countries in Europe on account of its low scores for bioethical freedom, ethnic diversity, and religious fractionalization. The chart shows that Poland is close to Armenia and Iceland, whose indicators also deviate from the average (religious homogeneity likely played a role here).

9.12. Spatial factor for the “Culture” section indicators

A comprehensive analysis of “Culture” section indicators allows us to identify certain spatial effects in their distribution.

None of the indicators we looked at demonstrated a sufficiently high Moran’s I for the geometric and geopolitical neighbourhood matrices. This means that, in general, the relationship between cultural indicators and geographic and geopolitical location is not excessively high. This is due to the unique nature of most of the indicators that were selected for the study, and their combination for most countries in particular.

Of all the indicators, only the bioethical freedom index demonstrated a sufficiently large spatial autocorrelation (Moran’s I of 0.534), but only for the geometric neighbourhood matrix. It is also the only indicator in this section for which a significant geographically weighted regression pattern was found (this will be discussed later). Overall, the hypothesis that the geopolitical neighbourhood has greater significance is not confirmed for the “Culture” section: in all cases, Moran’s I turned out to be lower for geopolitics than for geometry.

For almost all indicators in this section, a two-factor analysis yields a spatial effect index greater than one in very few cases (one or two indicators). The bioethical freedom index mentioned above does not make it into this list, as the two-factor Moran’s I squared was greater than the coefficient of determination (R-squared) for ten indicators. Ethnic fractionalization showed similar results, with the two-factor Moran’s I squared being greater than the coefficient of determination (R-squared) for six indicators.

Interestingly, compared to the results of our analysis of the “Geography” section, the spatial effect index produced a high result for one indicator in the “Culture” section, namely, “Ethnic minorities” — indicators of geographic latitude and climate (Fig. 9.12.1).

At the next stage, geographically weighted regressions were calculated for all indicators in this section. The most significant geographically weighted regression model in the “Culture” section was for bioethical freedom, which is inversely related to the average annual temperature and directly dependent on the scope of business lending and the number of doctors per 1000 population. In the case of temperature, much like the studies of Tatu Vanhanen on the factors that influence the development of democracy, we are not suggesting that temperature has a direct influence on bioethical freedom, simply that the countries that demonstrate the highest scores on the bioethical freedom index — the developed states of Northern Europe, Benelux and Canada — are spatially located in the zone of lower mean annual temperature, and vice versa. Further, a large number of doctors indicates a high level of development of the healthcare system, medical research and medical services. This, in turn, affects the ability of medical structures to

Bioethical Moral Freedom (BIOETF)

Model selection criterion	Indicator	Value	Significance level
Normality of errors	JB p-value > 0,1	—	0,554942
Heteroskedasticity	K (BP) p-value < 0,05	—	0,020548
Multicollinearity	VIF < 7,5	1,645992	—
Spatial Autocorrelation	Moran's I p-value > 0,1	—	0,112304
Lagrange Multiplier — Geometry Weights	Lagrange Multiplier (lag) Robust LM (lag)	2,9350 1,6309	0,09 0,20
	Lagrange Multiplier (error) Robust LM (error)	1,5450 0,2408	0,21 0,62
Lagrange Multiplier — Geopolitics Weights	Lagrange Multiplier (lag) Robust LM (lag)	10,1598 8,2382	0,001 0,004
	Lagrange Multiplier (error) Robust LM (error)	2,0726 0,1509	0,15 0,7

	OLS	SAR geometry	SAR geopolitics
Constant	46,574482 (0,00000)	3090,8 (0,21536)	3344,56 (0,25313)
W_BIOETF	—	0,194945 (0,02160)	0,29171 (0,00049)
5MEANTEMP	11,9465 (0,00001)	12,2608 (0,00000)	11,9256 (0,00000)
CREDDOMBUS	17,7084 (0,00000)	15,0263 (0,00000)	16,7979 (0,00000)
DOCTORS	1219,95 (0,00127)	1281,19 (0,00018)	1247,3 (0,00035)
Heteroskedasticity (Breusch-Pagan test)	13,0999 (0,00443)	32,7435 (35,2121)	43,8799 (0,00000)
Normality of errors (Jarque-Bera test)	1,2662 (0,53094)	—	—
Spatial dependence (Likelihood Ratio test)	—	3,3403 (0,06760)	0,8588 (0,35409)
Akaike info criterion	1271,53	1413,78	1416,26
Schwarz criterion		1283,52	1427,21
R-squared	0,557269	0,819559	0,811769

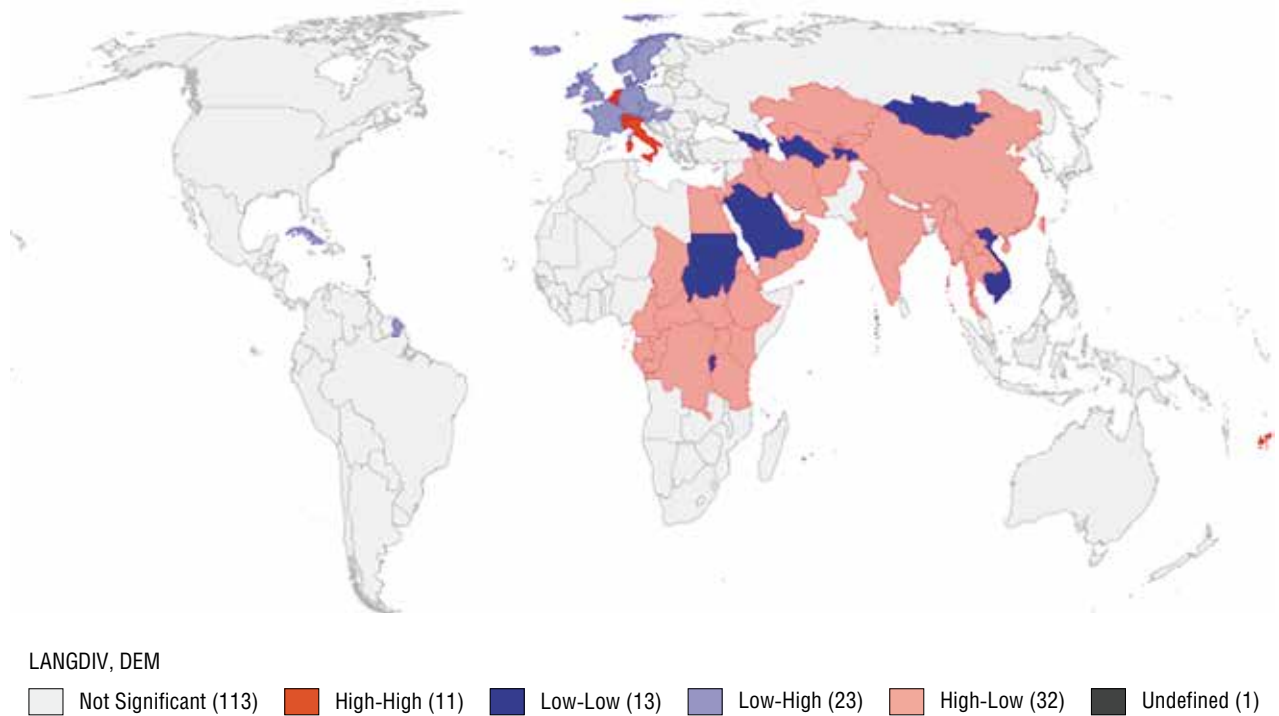


Fig. 9.12.1. Cartogram of local indicators of spatial autocorrelation of the share of the largest ethnic minority with the geographical latitude of the capital

participate in genetic research, develop stem cell medicine and provide surrogacy services, as well as the likelihood that these areas will be regulated at the legislative level (and liberalized), which will be reflected in the index. Domestic business lending also contributes to the development of the medical industry, including private clinics that provide surrogate services and organ synthesis operations. What is more, it encourages private initiative, which also stimulates the development of moral freedom.

The Lagrange multiplier revealed that a spatial autoregressive model (SAR) can be used for geographically weighted regression (GWR) for this parameter. In this case, the Schwarz information criterion for the model we have described shows that this model is more valid for geometric neighbourhood weights.

The cartogram of the standard regression model deviation for “Bioethical freedom” indicates that this geographically weighted regression model is most applicable to Latin America, North Africa and the Arabian Peninsula. These dependencies are the least relevant for Chile, Finland, Bhutan, Angola and Lesotho, as well as for Mexico, Guyana, Uruguay, South Africa, Ukraine, Hungary, Cyprus, Turkmenistan, India, Thailand, Cambodia, Vietnam and Australia.

In general, the spatial effect in the distribution of indicators in the “Culture” section is rather small. This is not particularly surprising, given the specific cultural characteristics. That said, while the relationship between the spatial factor and cultural characteristics is not typically obvious at the global level, then certain interdependencies were identified at the regional and local levels. Cultural diversity in the world is structured according to the principle of regionality, which confirms the well-known assumption that the world is divided into spatially continuous civilizational associations. The absence of global spatial dependencies in culture suggests that the contradictions between these civilizational groups are still stronger than the globalization tendencies to unify the differences between them.

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10 *Mobility*

Capitalness

Money transfers

Inbound tourism

Mobile subscribers

Internet users

Railway network

Motorways

Petrol prices

Load on freight ports

Air passengers

THE “Mobility” section covers indicators primarily from applied areas that are related to both political and managerial fields of activity. Before describing the indicators that have been selected for this section, we need to define what the concept of “mobility” actually means. And there are many possible interpretations. We should point out immediately that the concept of “mobility” in this section should be taken in isolation from the usual interpretation proposed by the sociologist Pitirim Sorokin, who defined it as a social phenomenon meaning the transition of an individual or group from one social position to another. Of course, this interpretation has the right to exist, but it would restrict the scope of what we were able to do in this study in terms of the cartographic method. Plus, without proper justification, it is not directly related to political geography. Our task was to approach the understanding of “mobility” in the broadest sense of the word, from a position of movement — the flow of “things,” “signals” and “people,” which can be represented in one way or another in a cartogram. Thus, the concept of “mobility” in this section has the literal meaning of “movement,” or, more precisely, the “ability to move, moveability.” In this sense, we can note that “mobility” has a common root with the word “mob,” which suggests that movement is chaotic and unpredictable, while at the same time being massive and all-encompassing.

Mobility is a multifaceted and complex concept, covering countless phenomena and processes, including globalization, urbanization, migration, and the development of modern telecommunications technologies. Putting it this way — constant dynamics where “anyone can be replaced with anyone” — only confuses the already complex picture of the structure of the human community. To counter this, we have identified relatively measurable features of mobility, with some assumptions that can be quantified in order to collect statistical data and form a “picture,” or profile, of each country. Thus, in our definition, mobility can be seen as a combination of the following characteristics:

1. “Moveability” proper — the general possibility of moving a particular resource (goods, capital, labour, information) across inter-state borders or within the territory of a state.
2. The lack of territorial attachment — the independence of mobility from the territory in which movement takes place. For instance, if you have an internet or mobile connection, you can transfer data over any distance without having to establish direct contact (distance and territorial features lose their significance).
3. Infrastructural provision of the ability to move — the presence of actual mobility channels (transport routes, mobile and internet networks) that affect the speed and complexity of movement.

4. The spatial organization of society within the state. The purpose of movement is to occupy a position, so this aspect of mobility gives us an idea of its effects in terms of statistics. This primarily refers to one of the indicators we have selected for this section — the capitalness coefficient, which indicates the capitalness type of a given country in accordance with the modified ratio of the population of the three largest cities to the capital city.

The understanding of mobility as the movement of anything formed the basis of the “new paradigm” of sociology in the post-industrial era developed by such researchers as John Urry, Vincent Kaufmann, Ole B. Jensen, David Manners, Tsugio Makimoto and Nigel Thrift.

If we look at mobility as a special form of organizing a community and the interactions within it, then we can state that this category has a significant impact on human development. It is mobility that determines the frequency and intensity of the exchange of goods, services, information and the means of production, and this is directly related to the economic, social and cultural development of both the population of an individual state and of the world as a whole.

The approach to the definition of mobility that is most relevant and applicable to this section is the one developed by the British sociologist John Urry. According to him, any processes that take place in society in one way or another represent a dynamic interaction between certain subjects, and this interaction displays such characteristics as intensity, speed and distance between participants. And it is mobility that makes such interaction possible. There are five main forms of interaction:

- The physical movement of people for whatever reason (tourism, labour and educational migration), regardless of duration and distance.
- The movement of goods and material resources from senders to recipients (as gifts or as a purchase), in particular, from producers to consumers.
- Broadcasting messages through mass media and communication channels (the virtual movement of data).
- Virtual movements in real time, which nullify actual distances and social distance (i.e. the position of social groups in social space).
- Messaging: the bidirectional communication of people via the internet, mobile phones, landline telephones, telegraph, and post.

We selected ten indicators based on these characteristics of mobility and with due account of the varieties of “mobility” we outlined above that exemplify the idea of mobility put forward at the beginning of this section.

The indicators were selected on the basis of the thematic blocks described above and can be conditionally divided into three groups: the movement of people (tourism, migration); interactions and communications (the transmission of information and messages); and the transport network (the transportation system infrastructure and capabilities).

Our initial goal was not to reproduce the indicators from the human development index, but rather to have an updated set of indicators. As a result, we were able to collect indicators from various sources, including the World Bank, the International Telecommunication Union, the International Civil Aviation Organization, the International Labour Organization, and the independent national statistics aggregator ccitypopulation.de.

10.1. Capitalness

The capitalness coefficient is operationalized as the ratio of the population of a given country's capital to the combined population of its three largest cities. The data was calculated on the basis of the capitalness coefficient formula α developed by I.Y. Okunev. The indicator is needed to determine the spatial structure of the state and ways to organize mobility within it. No statistically significant spatial relationships were identified when evaluating this indicator. The score on this indicator tells us what type of capital city we are dealing with: < 0.5 means a micro-capital of a polycentric state; $0.5\text{--}1.5$ means a macro-capital of a polycentric state; and, > 1.5 means a macro-capital of a monocentric state. The percentile cartogram (Fig. 10.1.1) thus allows us to classify the capitals of the countries we are looking at. Barbados, Liberia and Guinea-Bissau, for example, are monocentric states with macro-capitals, which indicates that movements within these countries are centralized and geared towards the capitals — the largest economic, social and cultural centres of the respective states. The high scores that these agrarian countries receive for the capitalness coefficient are an indicator that their capitals likely act as the main, and indeed only, “centres” of urbanization.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.013	0.335	0.011	0.293
Geary's C	0.963	0.234	0.983	0.293

The countries that scored the lowest on this indicator are those where the capital city plays a political and administrative function only, as the location of all the government bodies. In terms of population and the level of socioeconomic activity, these capitals are inferior to other large cities in the country. It is thus quite natural that the lowest scores are observed in the following countries:

Global place	Country	Indicator
1	Barbados	2.83
2	Liberia	2.79
3	Guinea-Bissau	2.74
Median (88–89)	France, Sri Lanka	1.81
Mean (108)	(Qatar)	1.66 (1.65)
188	Oman	0.14
189	United States	0.13
190–191	Pakistan, Australia	0.1

- Australia, Pakistan and the United States — federal states whose capitals are separate subjects with a special status (the Australian Capital Territory, the Islamabad Capital Territory and the District of Columbia, respectively), and the economic centres are concentrated in cities in other regions of the country (Melbourne, Sydney, Karachi and New York, respectively);

- Oman — an absolute monarchy where the capital, Muscat, without agglomeration, is the residence of the Sultan.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Neither the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.1.3) nor the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.1.4) show significant neighbourhood clusters because the spatial autocorrelation index is not statistically significant.

The likelihood-ratio test for the “Capitalness” indicator (Fig. 10.1.2) reveals those cases where physical neighbours of the country in question are still those with the closest scores on the indicator in question. The corresponding cartogram shows the prerequisites for the similarity of capital city types in Europe, Latin America, Southern and Western Africa, and the countries of the Asia-Pacific. However, most countries do not have many geographic neighbours. This suggests that, despite the similarity of certain regions in terms of their historical development (the colonial past of Latin America, the nation-building in the countries of Europe) — a prerequisite for their being clustered together — this type of capital city depends more on the specifics of the country in question and the organization of its territory.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Female population	0.036	0.01	0.106	0.312111
2	Female employment	0.025	0.034	0.082	0.26896
3	Petrol prices	0.027	0.036	0.083	0.255148
4	Hospital beds	0.057	0.015	0.118	0.244281
5	Publication activity	0.027	0.024	-0.074	0.202815
6	GDP (PPP) per capita	0.039	0.007	-0.085	0.185256
7	Access to electricity	0.029	0.018	-0.073	0.183759
8	Healthcare spending	0.046	0.003	-0.089	0.172196
9	Debt inward FDI stock	0.048	0.016	-0.089	0.165021
10	IMF voting power	0.043	0.004	-0.077	0.137884

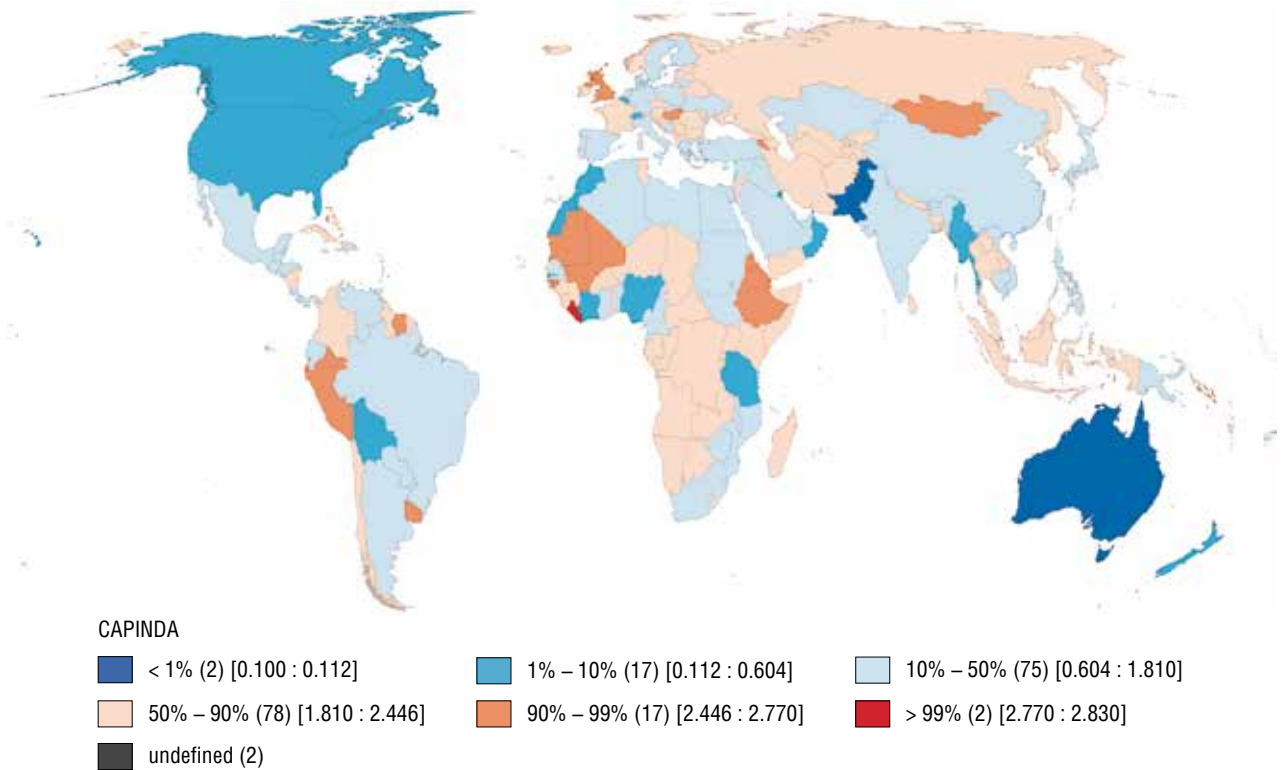


Fig. 10.1.1. Percentile cartogram for the “Capitalness” indicator

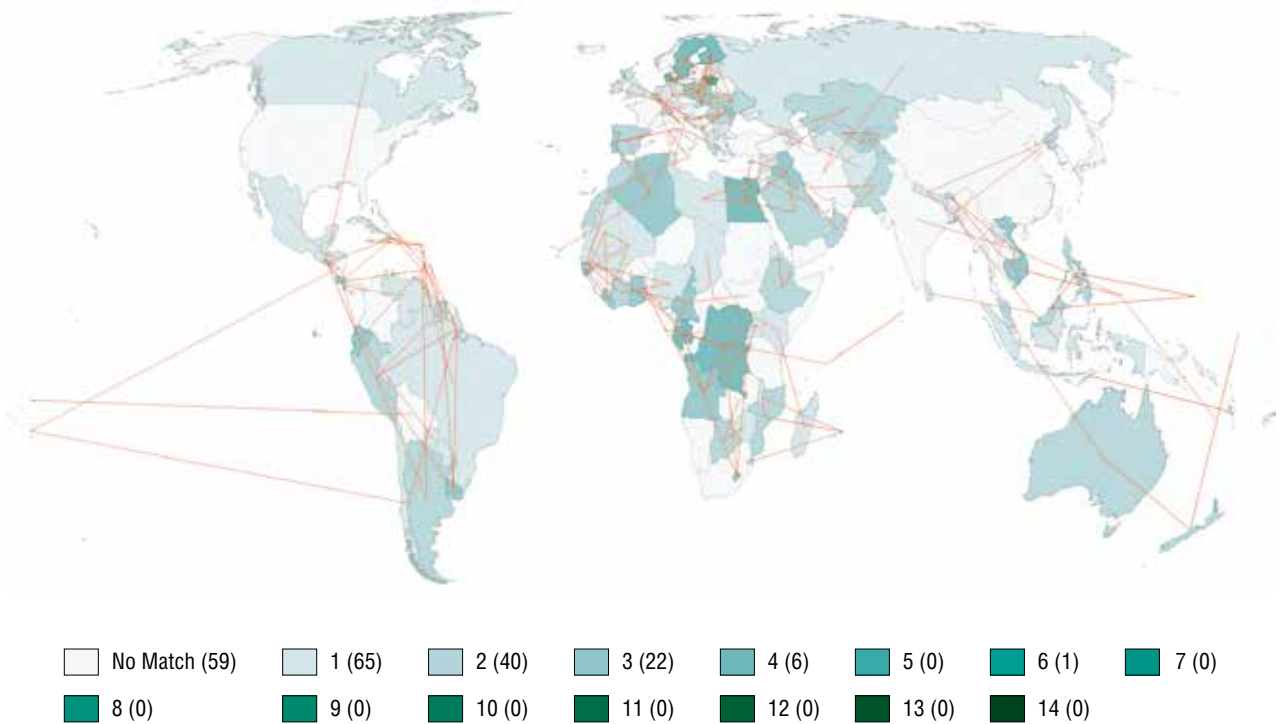


Fig. 10.1.2. Likelihood-ratio test for the “Capitalness” indicator

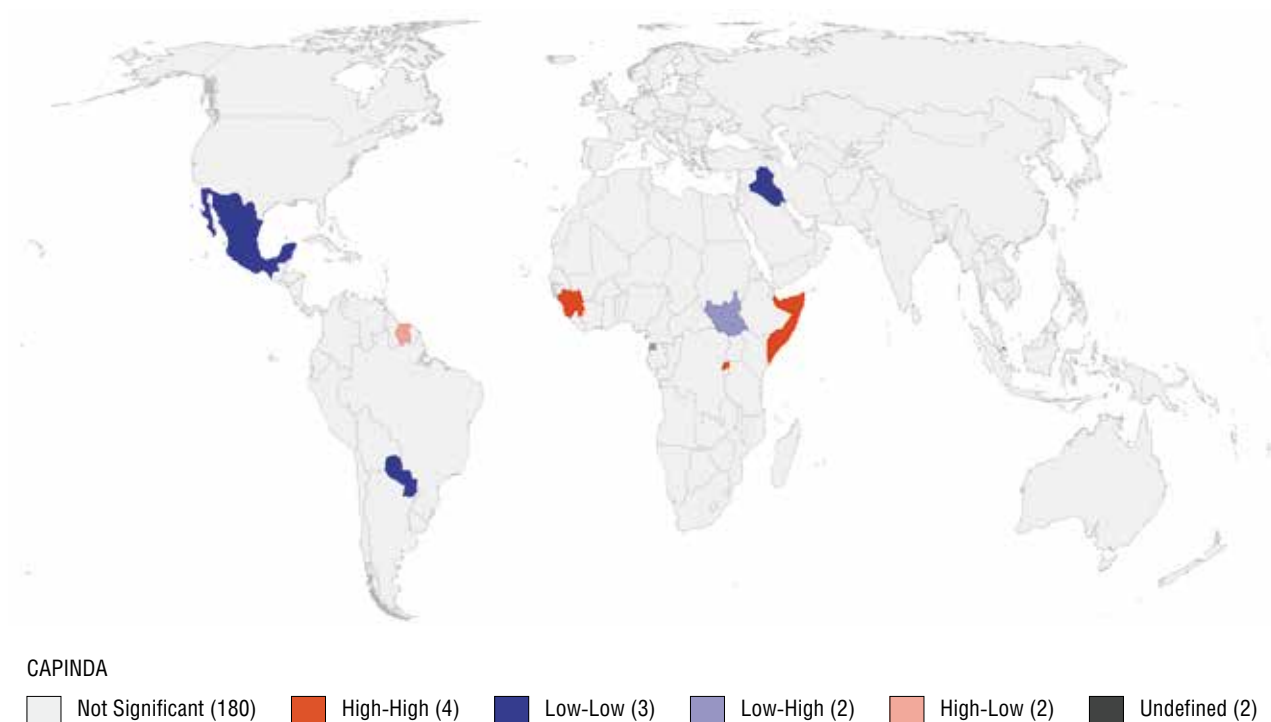


Fig. 10.1.3. “Capitalness” spatial autocorrelation cartogram for the geometric neighbourhood matrix

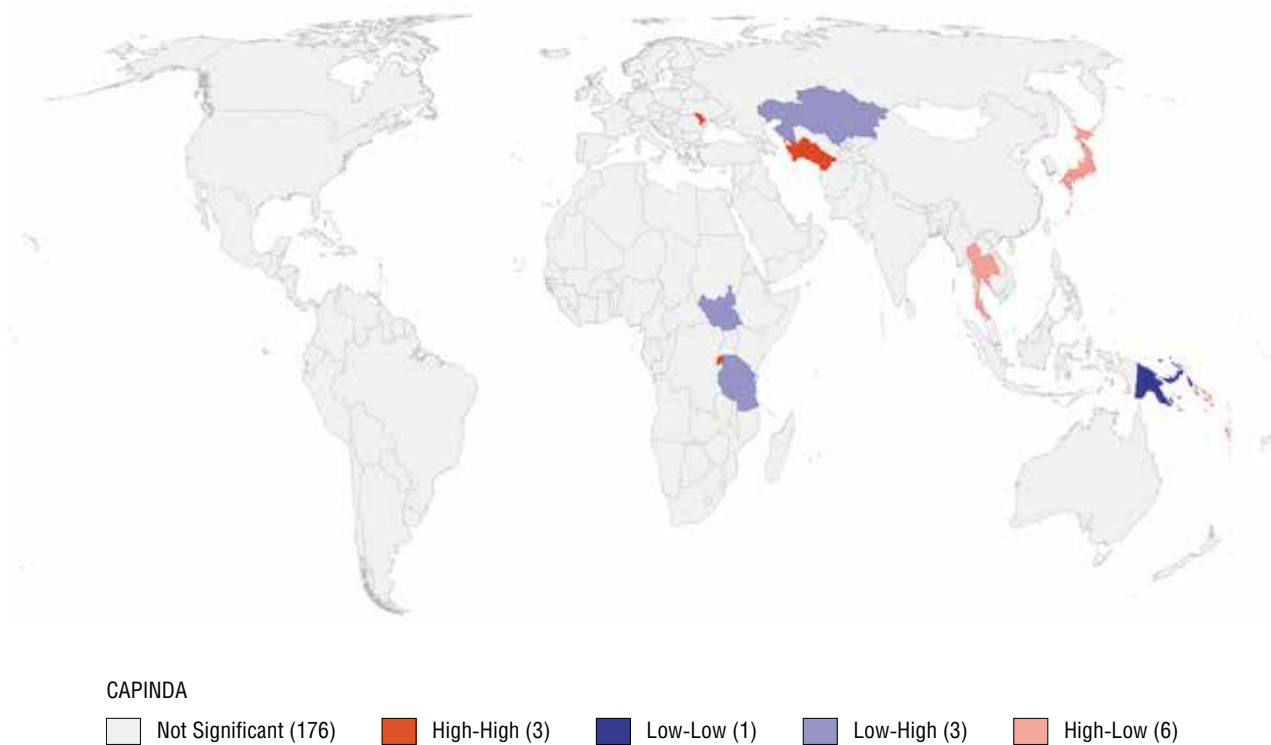


Fig. 10.1.4. “Capitalness” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.2. Money transfers

Money transfers refers to the size of remittances sent home by migrants working in other countries, and is represented as a share of the country's GDP. This indicator is useful for demonstrating the degree to which the wellbeing of people in a country depends on sources outside of it. An assessment of the role that space plays in determining the values for this indicator reveals a weak positive relationship.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.220	0.000	0.104	0.000
Geary's C	0.714	0.000	0.891	0.000

The percentile cartogram (Fig. 10.2.1) shows that the countries that are most dependent on remittances from abroad are those with a large number of emigrants who leave their homeland in order to find work or receive an education. Examples of such countries include Mexico, India and the Balkan states. However, in terms of GDP share, the leaders here are Tonga (a state in Polynesia that is largely dependent on the economic support of its neighbours, primarily New Zealand and Australia), followed by Kyrgyzstan and Tajikistan, many citizens of which end up as labour migrants in other post-Soviet states and provide financial assistance to their families by transferring money back home.

Low indicator scores suggest that most people do not need to leave the country in order to improve their financial situation and provide for their families, or that their country lacks the infrastructure to deal with regular transfers of relatively large amounts of money to the country from abroad.

In the case of countries such as the United States, Norway, United Kingdom, Ireland, New Zealand, Canada, Japan and Australia, the volume of remittances is small due to the high level of prosperity in these

Global place	Country	Indicator (% of GDP)
1	Tonga	35.2
2	Kyrgyzstan	33.6
3	Tajikistan	31
Mean (54)	(Uganda)	4.68 (4.5)
Median (87–88)	Vanuatu, Portugal	2
146–155	Norway, Botswana, Suriname, Turkey, Ireland, United Kingdom, Uruguay, Kazakhstan, Greece, Brazil	0.2
156–161	New Zealand, Canada, Japan, Maldives, Argentina, Australia	0.1
162–174	San Marino, Angola, Congo, Saudi Arabia, Kuwait, Turkmenistan, Papua New Guinea, South Sudan, Gabon, Somalia, United States, Chile, Oman	0

states and the fact that there is thus no need to emigrate to another country. Meanwhile, leaving countries such as Botswana, Suriname, Uruguay, the Maldives, Angola, Turkmenistan, Papua New Guinea, South Sudan, Gabon, Somalia, Chile and Oman is difficult due to various reasons: financial and economic (the lack of funds to move and find work abroad); cultural (a poor education system limits opportunities to study in foreign universities); political (the state is closed and isolated from external relations); or geographic (the country's remote location, challenging terrain or difficult climate make it difficult for people to travel abroad, including by air).

Scores on the spatial autocorrelation index indicate that there is a weak positive relationship between space and the indicator values. The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The “Money transfers” spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.2.3) does not show any significant clusters, with the exception of a cluster of low values in Western Europe that includes France, Germany, the Netherlands, Belgium, Luxembourg, Denmark, Sweden and Norway. This cluster likely emerged due to the high level of domestic development in these countries, meaning that there is no need to look for sources of income abroad.

The “Money transfers” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.2.4) allows us to identify larger clusters, primarily low-value clusters concentrated in the countries of the Western Hemisphere, including the NAFTA and MERCOSUR countries and other Latin American states, as well as a European cluster that includes Turkey.

The likelihood-ratio test for the “Money transfers” indicator (Fig. 10.2.2) demonstrates significant variation in values: most countries either had no neighbours with similar scores, or at most two. Potential clusters that are worthy of note include one in Western Europe and another in Eastern Europe that exist separately from one another, and a South Asian and Middle Eastern cluster that connects the Arabian Peninsula to Central Asia. This suggests that people who live in cluster-like regions have the same opportunities when it comes to relocation and employment, and that they strive to make the most of these opportunities.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Healthcare spending	0.085	0	-0.188	0.415812
2	Regional trade agreements	0.055	0.002	-0.144	0.377018
3	Number of doctors	0.052	0.003	-0.133	0.340173
4	Particulate air pollution	0.028	0.041	0.096	0.329143
5	Women in politics	0.037	0.011	-0.11	0.327027
6	Elderly population	0.042	0.008	-0.113	0.304024
7	Publication activity	0.093	0	-0.168	0.303484
8	IMF voting power	0.035	0.013	-0.096	0.263314
9	Royalties to foreign copyright holders	0.033	0.029	-0.093	0.262091
10	Alcohol consumption	0.072	0	-0.136	0.256889

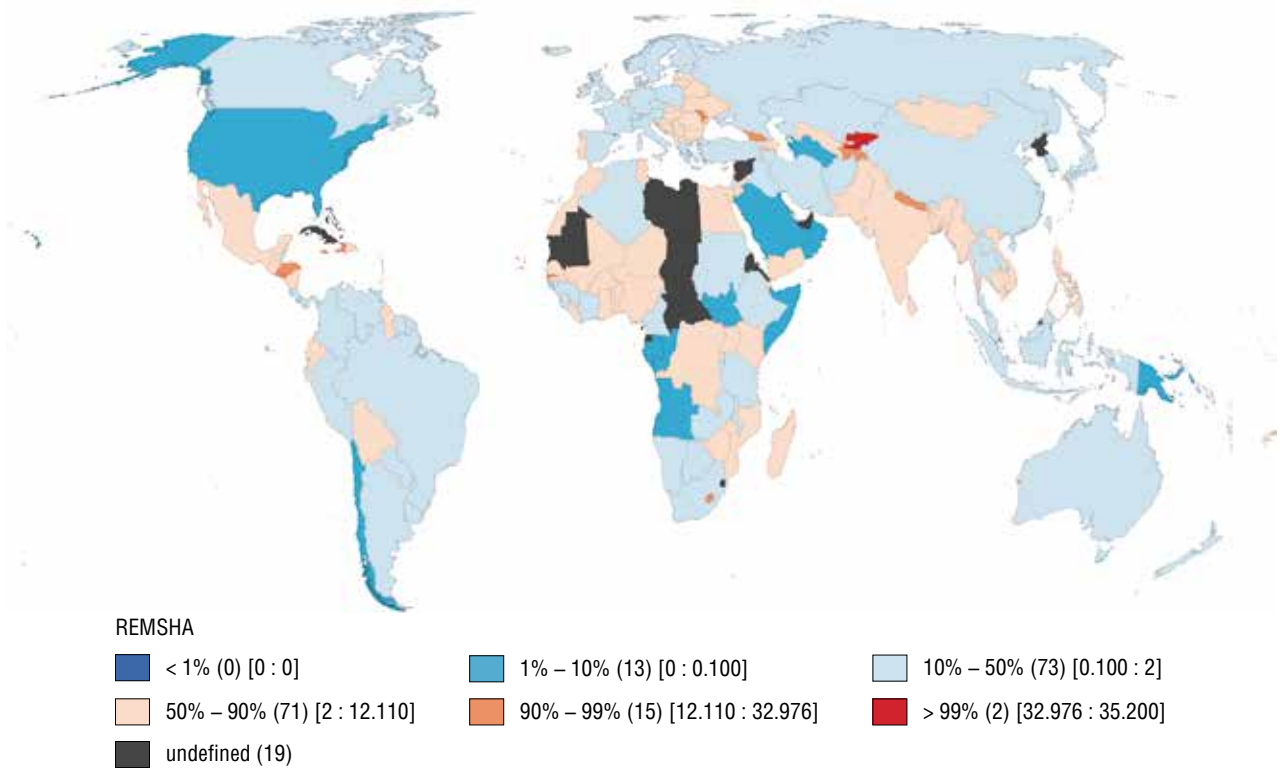


Fig. 10.2.1. Percentile cartogram for the “Money transfers” indicator

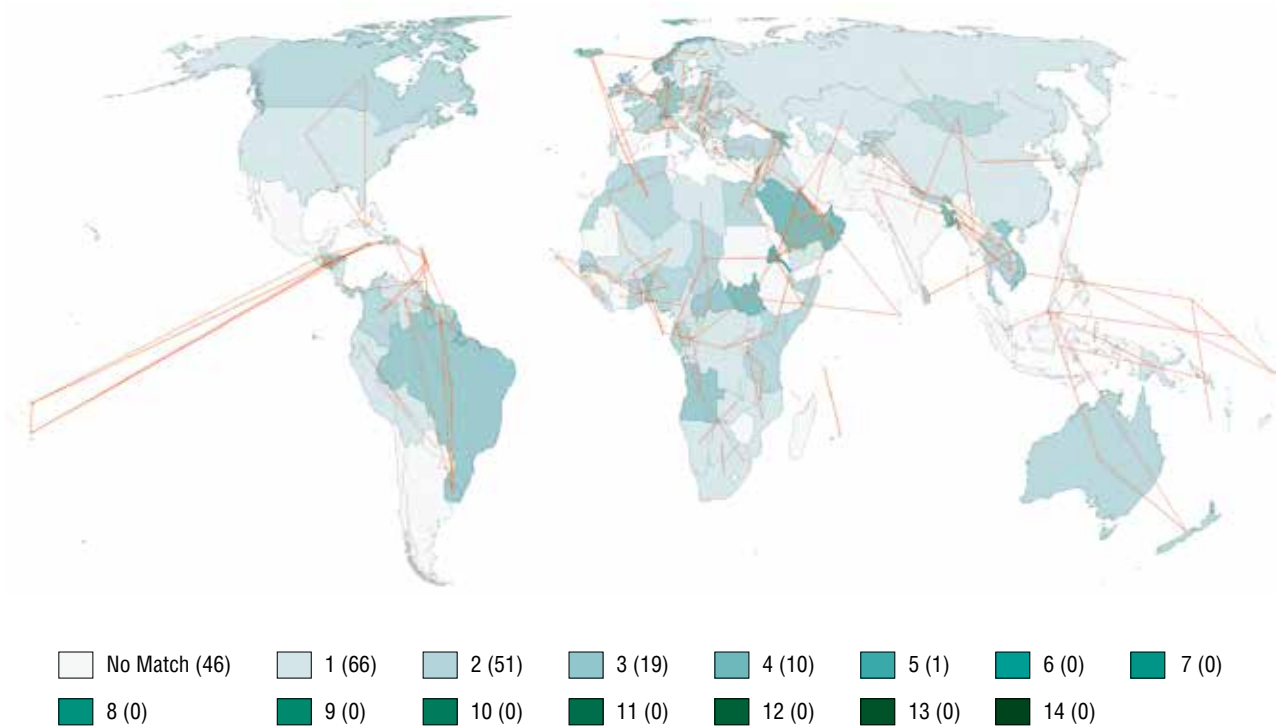


Fig. 10.2.2. Likelihood-ratio test for the “Money transfers” indicator

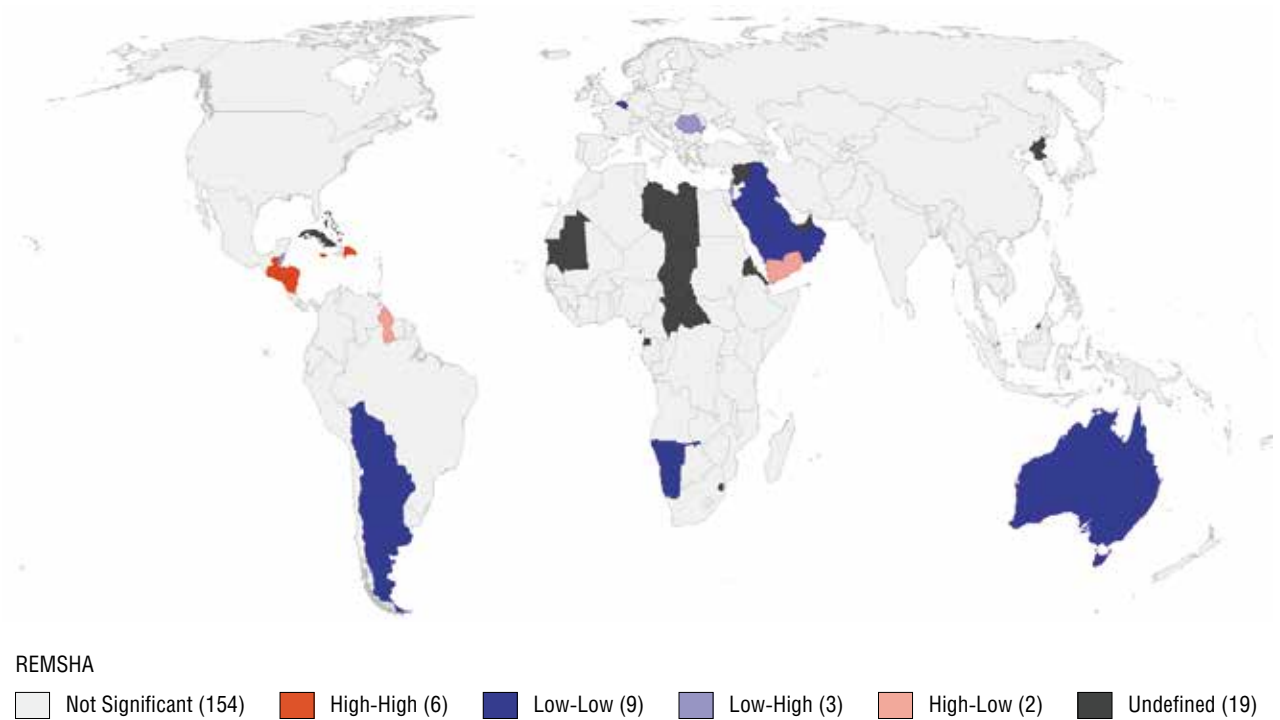


Fig. 10.2.3. “Money transfers” spatial autocorrelation cartogram for the geometric neighbourhood matrix

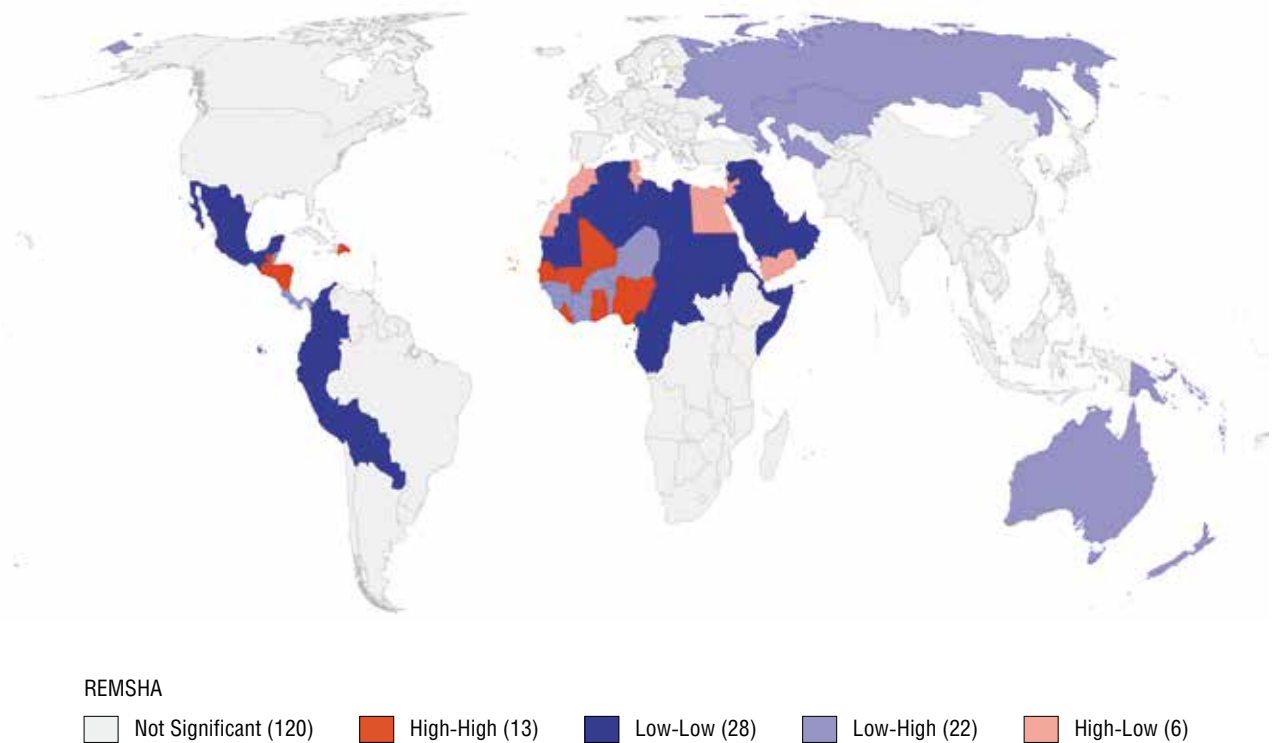


Fig. 10.2.4. “Money transfers” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.3. Inbound tourism

Inbound tourism refers to the number of people who have visited the county within the past 12 months (in millions). It is an indicator of the tourist attractiveness of a given country and the readiness of its infrastructure to receive a large number of tourists.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.270	0.000	0.159	0.000
Geary's C	0.819	0.011	0.837	0.000

The percentile cartogram (Fig. 10.3.1) shows that France and Spain are the most popular destinations among international tourists. Tourism in these countries accounts for approximately 10% of their GDP. Their tourist attractiveness can be put down to their mild oceanic climate and coastal position, as well as the variety of cultural attractions they offer, and their developed infrastructures. What is more, France and Spain are economically developed countries that are home to numerous large corporations, which makes them more attractive in terms of business tourism too. Other countries that are popular with international tourists include the United States and Canada, as well as Russia, which allows labour migration for a period of less than 12 months, and China.

The least popular destinations are small countries located in remote areas, mainly on the islands of the Pacific and Indian oceans. These countries exist primarily on agricultural exports and do not have sufficient resources to provide a decent tourism infrastructure. Moreover, they do not have such important tourism resources as transport accessibility or popular attractions.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Global place	Country	Indicator (million people)
1	France	86.9
2	Spain	81.9
3	United States	77.2
Mean (40–41)	(Sweden, Tunisia)	7.38 (7.1)
Median (83–85)	Lebanon, Latvia, Montenegro	1.9
138–143	Niger, Bangladesh, Guyana, Antigua and Barbuda, Kuwait, Mali	0.2
144–162	Papua New Guinea, Saint Kitts and Nevis, Chad, Burkina Faso, San Marino, Central African Republic, Tonga, Samoa, East Timor, Liechtenstein, Saint Vincent and the Grenadines, Vanuatu, Palau, Guinea, Grenada, Dominica, Moldova, Congo, Sierra Leone	0.1
163–169	Tuvalu, Marshall Islands, Comoro Islands, São Tomé and Príncipe, Kiribati, Guinea-Bissau, Solomon Islands	0

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.3.3) shows a significant cluster of high values formed by the countries of Central Europe (Switzerland, Germany and Poland), the Mediterranean (France, Spain and Italy), and Morocco. This can be explained by the ease of travel within Europe and proximity of these states to the sea, a factor that ensures high tourist mobility.

As for the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.3.4), the largest cluster of high values here includes the Asia-Pacific countries, members of the ASEAN+3 bloc that are attractive thanks to their coastal position and developed tourist infrastructure. However, Myanmar, Cambodia, Laos and the Philippines score relatively low in this high-value cluster. Nearby is a low-value cluster for the ANZUS–CU bloc, which is dominated by Australia compared to the other countries due to its attractiveness as a tourist destination.

On the one hand, the high-value cluster in several NATO and EU countries that border states that scored low on the indicator can be explained by the ease of access to these countries thanks to the visa-free regimes that have been established between them. On the other hand, the Nordic countries, where inbound tourism is not high, are characterized by a high cost of living, which could negatively affect tourist attractiveness, despite the fact that they are part of the Schengen Area and the region as a whole is attractive for tourists in terms of natural and cultural sites.

The likelihood-ratio test for the “Inbound tourism” indicator (Fig. 10.3.2) shows a high correspondence among European countries, where intra-European tourism is widely developed and free from red tape thanks to the integration processes that have taken place in the region. Another knot of corresponding results has formed in Southeast Africa, where countries that have a highly developed tourism industry are located. The smaller states in Latin America and Oceania also scored similarly in terms of the level of international tourism. It is noteworthy that there are practically no stable similarities in Asia (with the exception of the south-eastern part), which suggests that there is significant differentiation in terms of the level of international tourism in the region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Bank deposits	0.029	0.039	0.214	1.579172
2	Highly wealthy population	0.034	0.031	–0.221	1.4365
3	Railway network	0.041	0.028	0.221	1.191244
4	Hospital beds	0.041	0.049	0.193	0.908512
5	Particulate air pollution	0.049	0.008	–0.203	0.841
6	Access to electricity	0.058	0.002	0.208	0.745931
7	Internet users	0.109	0	0.283	0.734761
8	GDP (PPP) per capita	0.121	0	0.297	0.729
9	Years at school	0.086	0	0.25	0.726744
10	Number of researchers	0.122	0	0.286	0.670459

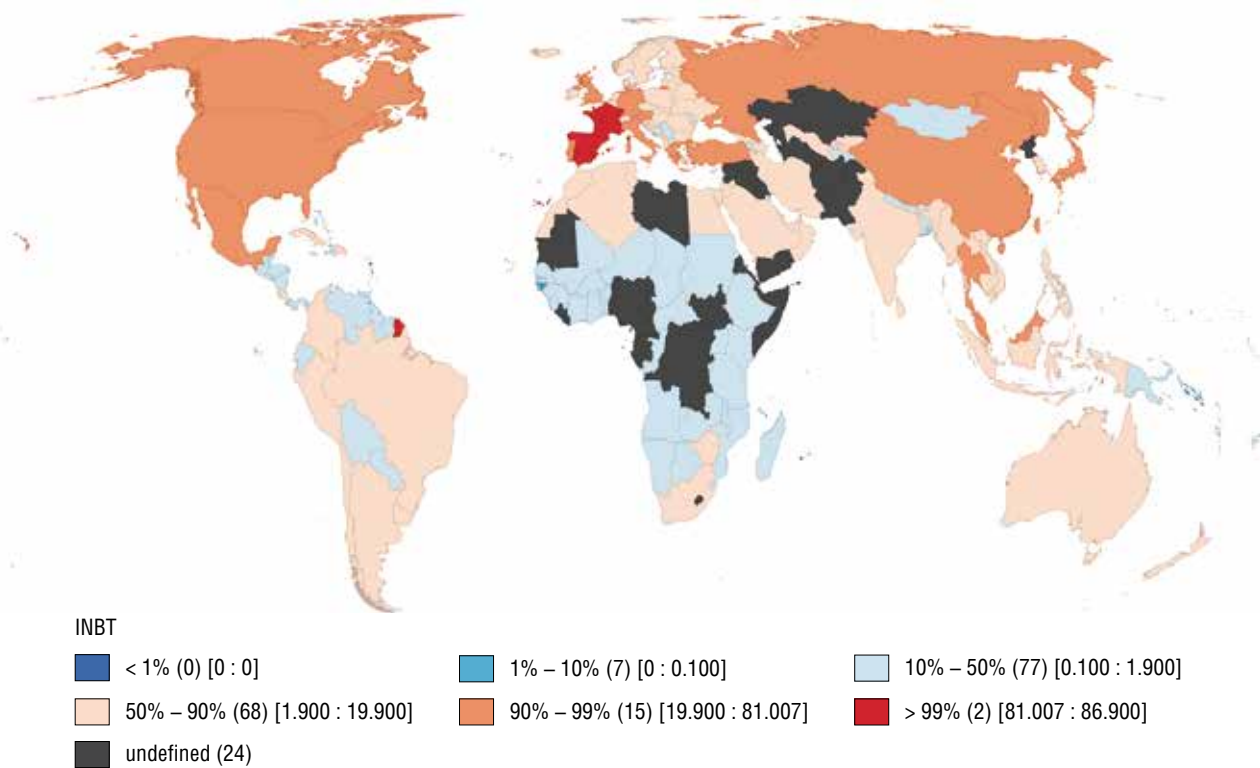


Fig. 10.3.1. Percentile cartogram for the “Inbound tourism” indicator

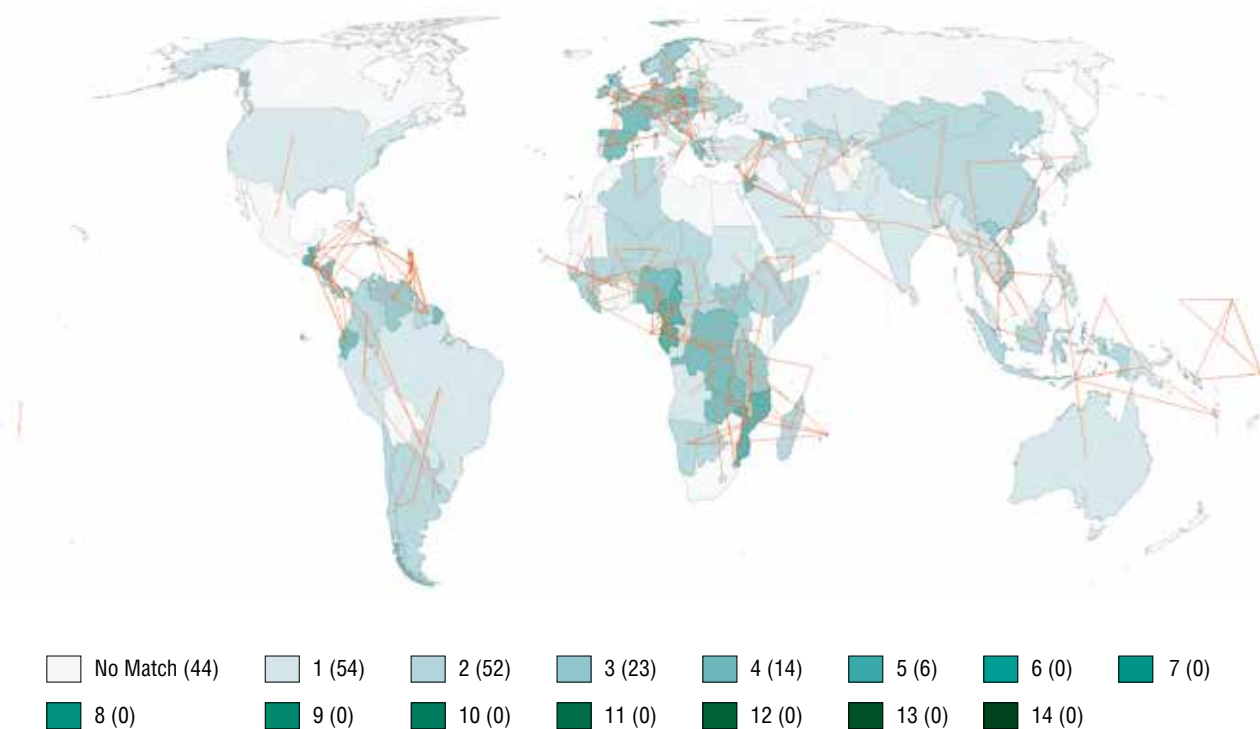


Fig. 10.3.2. Likelihood-ratio test for the “Inbound tourism” indicator

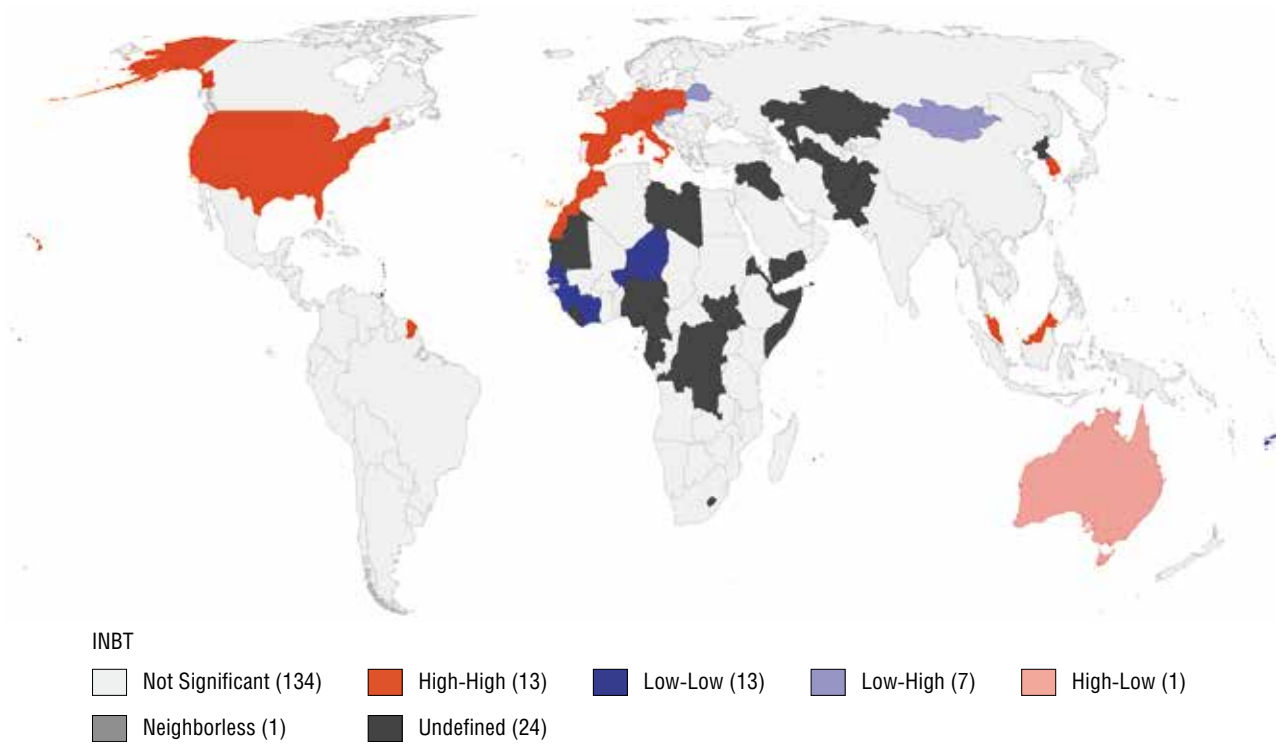


Fig. 10.3.3. “Inbound tourism” spatial autocorrelation cartogram for the geometric neighbourhood matrix

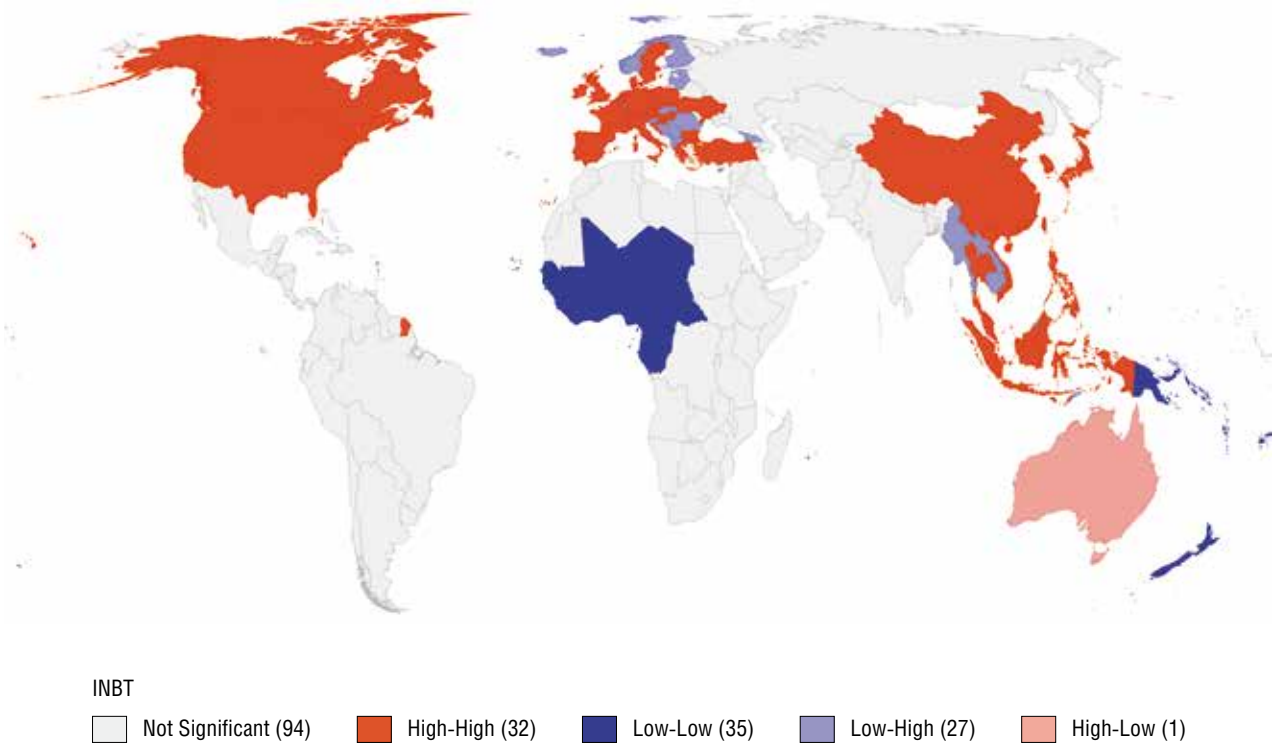


Fig. 10.3.4. “Inbound tourism” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.4. Mobile subscribers

Mobile subscribers refers to the number of devices connected to a mobile device per 100 people. It is an indicator of how accessible mobile communications are to the population. An assessment of the role of space in determining the scores for this indicator according to the geopolitical neighbourhood matrix shows a weak positive relationship.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.338	0.000	0.199	0.000
Geary's C	0.642	0.000	0.797	0.000

The percentile cartogram (Fig. 10.4.1) shows significant differences in the number of mobile subscribers in different countries. According to the cartogram, high values of this indicator are observed in different regions: Russia, Montenegro, South Africa, Thailand, and other countries. However, the absolute leader in the number of mobile subscribers is the United Arab Emirates. This is likely due to the fact that a significant number of labour migrants from other countries live in the country, and having a mobile phone (smartphone) is extremely important to them. At the foot of the table are the poorest countries in Africa: Malawi, the Central African Republic and South Sudan, where mobile communication is not considered a public good given the low level of wellbeing of the population. Similarly low rates of mobile subscribers are found in most other sub-Saharan African countries.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.4.3) reveals two large clusters: a high-value cluster that unites Russia and China, and a low-value cluster located in Central and East Africa.

Global place	Country	Indicator (users per 100 people)
1	UAE	208.5
2	Seychelles	184.3
3	Montenegro	180.7
Median (87)	Algeria	111.66 (111.66)
Mean (90)	(France)	108.2 (108.36)
171	Malawi	39
172	Central African Republic	27.41
173	South Sudan	17.46

The alignment of Russia and China in a single cluster of high mobile phone usage can be explained by the development of the services sector in both countries, which has increased the need for regular mobile communications to carry out work-related tasks. The low-values cluster in Central Africa points to the relative inaccessibility of mobile devices to the general population in this part of the world, a factor that increases the region's isolation from the outside world.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.4.4) reveals larger clusters that deserve special attention. First, the high-value cluster in Eurasia suggests that access to mobile networks is evenly distributed across the region. However, it also shows us that mobile communications are not as widely available in the “outlier” countries of Norway and Ireland, nor in Croatia and Montenegro. The difficulties in providing stable mobile network coverage in these countries may be related to the differences in elevation within the countries themselves and their climatic conditions. Another significant high-value cluster covers all of Southeast Asia, with the exception of Laos (due to the difficulties in developing mobile communications on account of the country's terrain). The widespread use of mobile communications in this region can be explained by the fact that the countries in question are highly developed economically and technologically.

The likelihood-ratio test for the “Mobile subscribers” indicator (Fig. 10.4.2) tells us which physical neighbours are also close in terms of their scores for this indicator. In the case of mobile subscribers, we can conclude that mobile coverage is distributed evenly in Europe, except for in Norway and France. A similar situation is observed in the countries of Oceania and Latin America (values are distributed uniformly). As for sub-Saharan Africa, we can state that mobile communications are equally inaccessible in most countries of the region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Linguistic diversity	0.039	0.01	-0.236	1.428103
2	Unused export potential	0.023	0.049	0.166	1.198087
3	Rate of gross accumulation	0.026	0.042	0.143	0.7865
4	Ethnic minorities	0.056	0.002	-0.209	0.780018
5	Population growth	0.073	0	-0.229	0.71837
6	Tuberculosis morbidity	0.084	0	-0.245	0.714583
7	Export	0.026	0.039	0.136	0.711385
8	Economic inequality	0.064	0.002	-0.207	0.669516
9	Cultural solidarity	0.035	0.024	0.15	0.642857
10	Female population	0.029	0.027	-0.136	0.637793

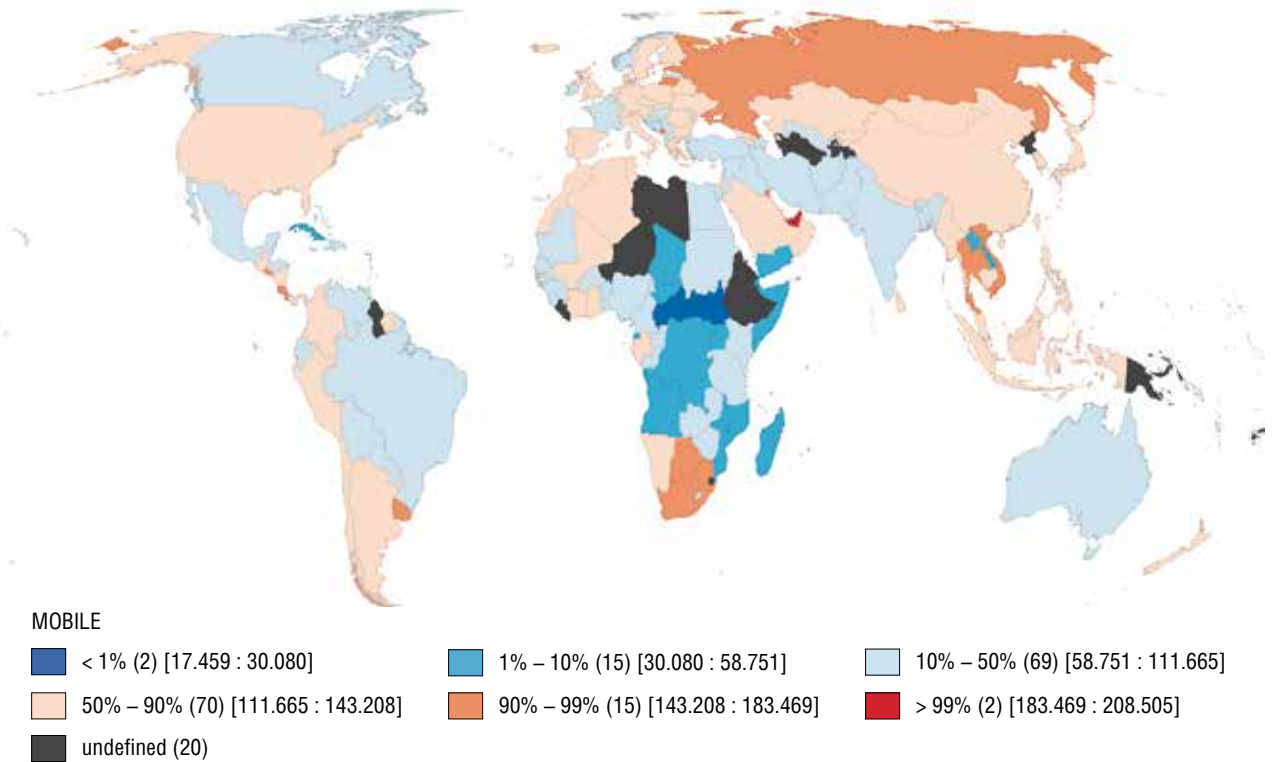


Fig. 10.4.1. Percentile cartogram for the “Mobile subscribers” indicator

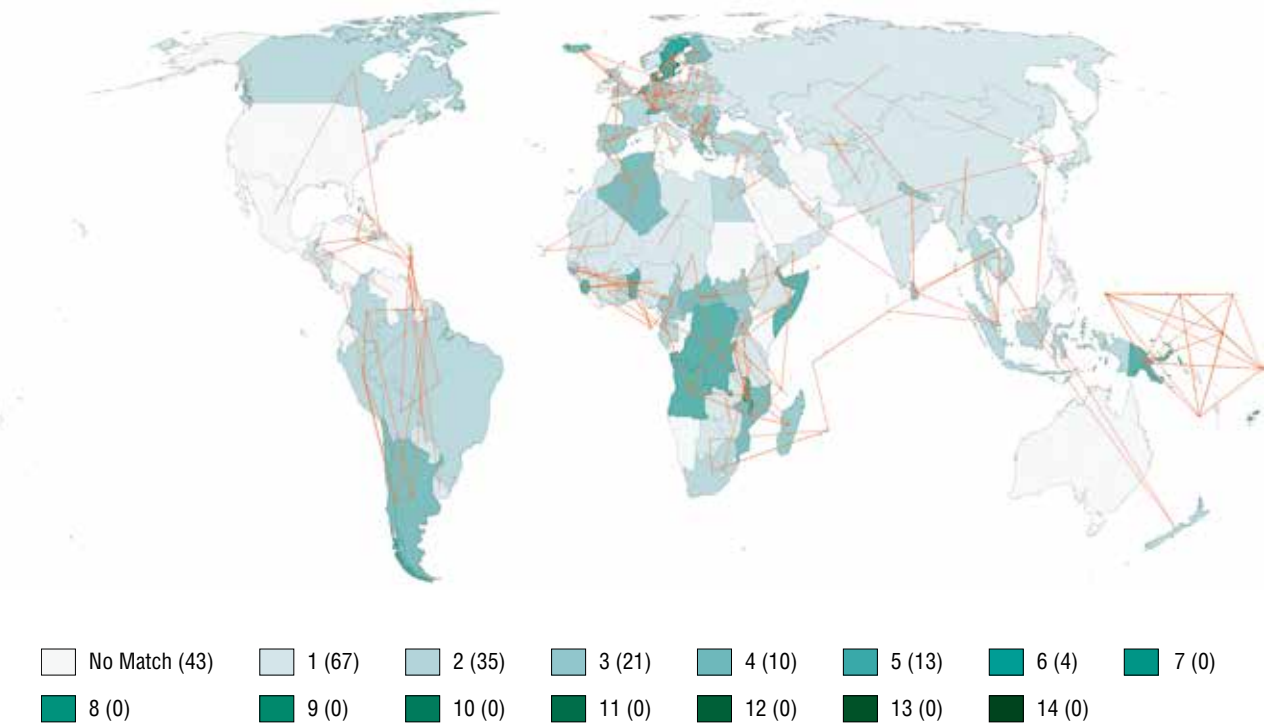


Fig. 10.4.2. Likelihood-ratio test for the “Mobile subscribers” indicator

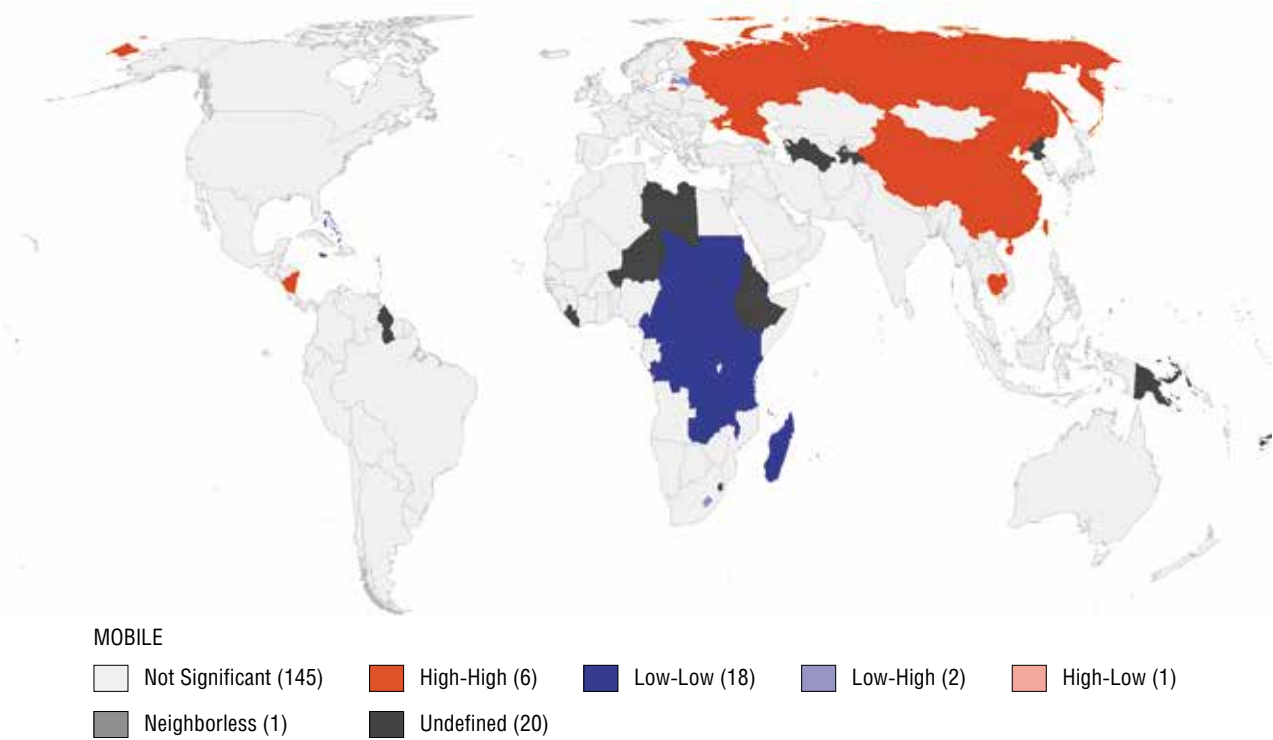


Fig. 10.4.3. “Mobile subscribers” spatial autocorrelation cartogram for the geometric neighbourhood matrix

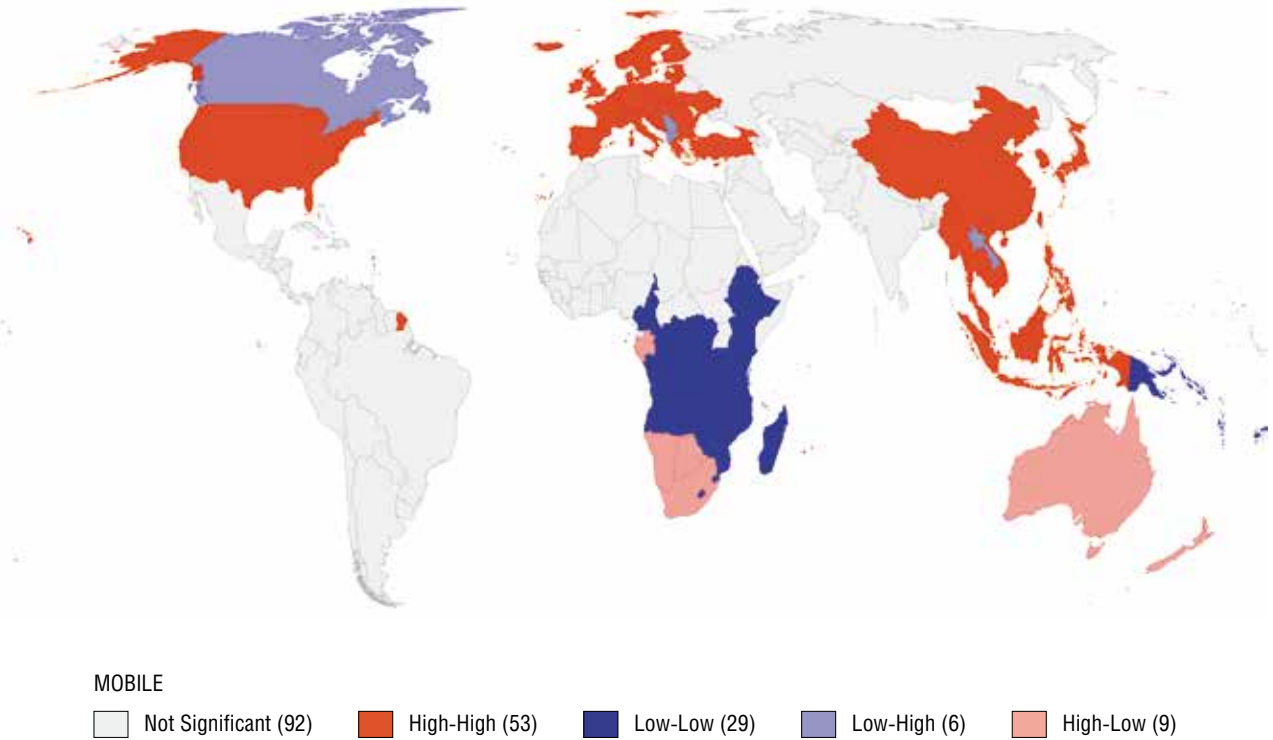


Fig. 10.4.4. “Mobile subscribers” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.5. Internet users

The “Internet users” indicator is operationalized as the proportion of the population of a given country that has uninterrupted access to the internet. It measures accessibility of the latest communication technologies for the general population. Assessing the role of space in determining the scores for this indicator, we can see a moderate positive relationship in terms of both the geometric and the geopolitical neighbourhood matrices.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.555	0.000	0.447	0.000
Geary's C	0.423	0.000	0.551	0.000

The percentile cartogram in Fig. 10.5.1 shows that a wide range of countries scored high on this indicator, including Canada, Iceland, Norway, Sweden, Finland, Japan and New Zealand. Luxembourg, Liechtenstein, Andorra and Monaco can also be found among those countries with high internet penetration. This is because the task of ensuring stable internet coverage across the country is easier owing to the high density of the population and the areas in which the people live. We should also note the low internet penetration in Southeast Asia (for example, in Myanmar, Laos and Cambodia) and Africa, where some countries (Guinea-Bissau, Somalia, Eritrea) are only able to provide internet access for less than 5% of the population.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.5.3) allows us to identify three significant clusters: a high-value cluster in Western and Northern Europe and Russia; a low-value cluster that includes Mali, Algeria and much of sub-Saharan Africa (excluding South Africa and its immediate neighbours); and, notably, another low-value cluster in India, which has a highly developed IT

Global place	Country	Indicator (% of the population)
1	Iceland	98.24
2	Luxembourg	98.13
3	Liechtenstein	98.09
Median (94)	Cape Verde	50.32
Mean (95)	(Tunisia)	49.23 (49.59)
185	Guinea-Bissau	3.76
186	Somalia	1.88
187	Eritrea	1.77

sector but poor internet coverage due to the large population, three quarters of which live in rural areas, and to the low incomes and high economic stratification.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.5.4) contains the high-value Euro-Atlantic cluster, where the share of internet users is high in all countries. Note also the emergence of several small and disparate low-value clusters in Western, Eastern and Southern Africa within the UEMOA–ECOWAS, EAC–IGAD and SACU–SADC blocs, with South Africa being an outlier here.

The likelihood-ratio test for the “Internet users” parameter (Fig. 10.5.2) allows us to state that Europe is not the only region that enjoys uninterrupted access to the internet, as Canada, Turkey and part of the Middle East also have this luxury. It is also worth noting that the prerequisites for clustering are present in the countries of Latin America, East Asia and South Asia.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Linguistic diversity	0.14	0	–0.391	1.092007
2	Women in politics	0.048	0,003	0.214	0.954083
3	Ethnic fractionalization	0.126	0	–0.34	0.91746
4	Population growth	0.251	0	–0.473	0.891351
5	Cultural solidarity	0.132	0	0.341	0.880917
6	Inbound tourism	0.109	0	0.306	0.859046
7	IMF voting power	0.082	0	0.259	0.818061
8	Ethnic minorities	0.076	0	–0.24	0.757895
9	Regional trade agreements	0.352	0	0.513	0.747639
10	Number of doctors	0.513	0	0.583	0.662552

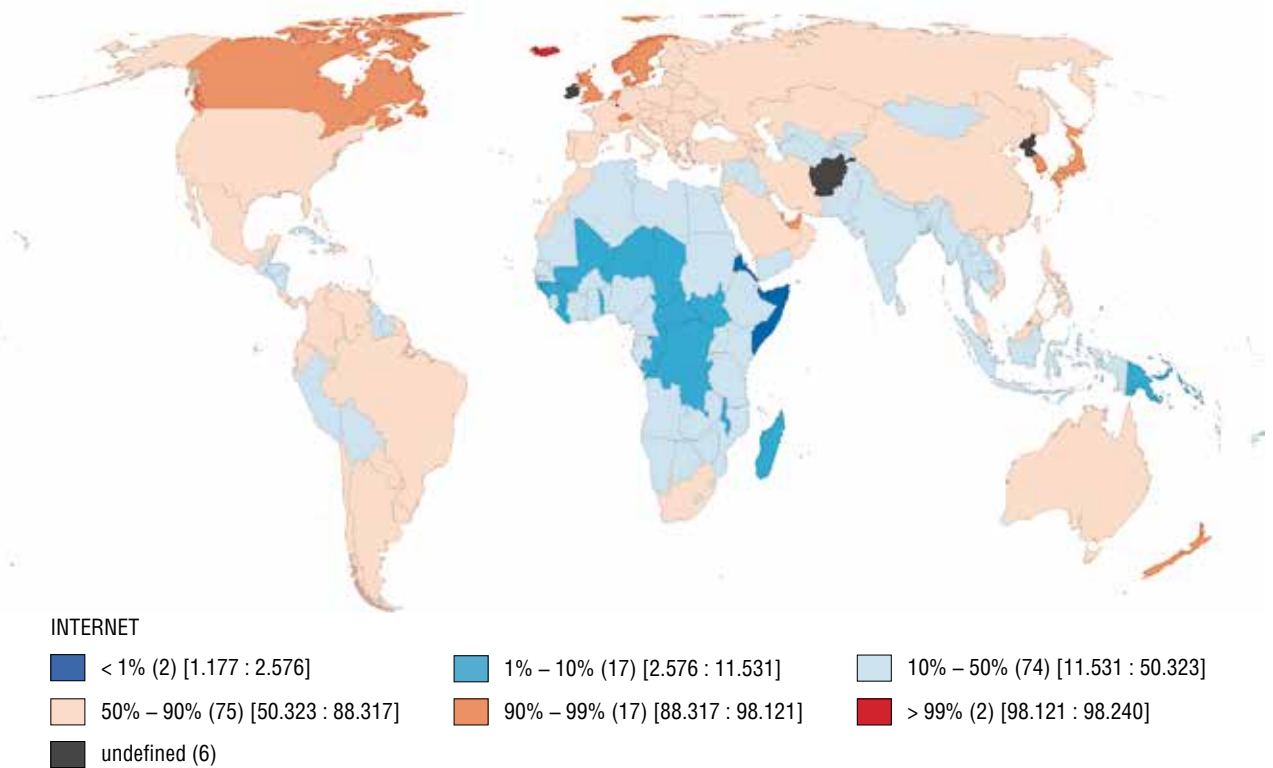


Fig. 10.5.1. Percentile cartogram for the “Internet users” indicator

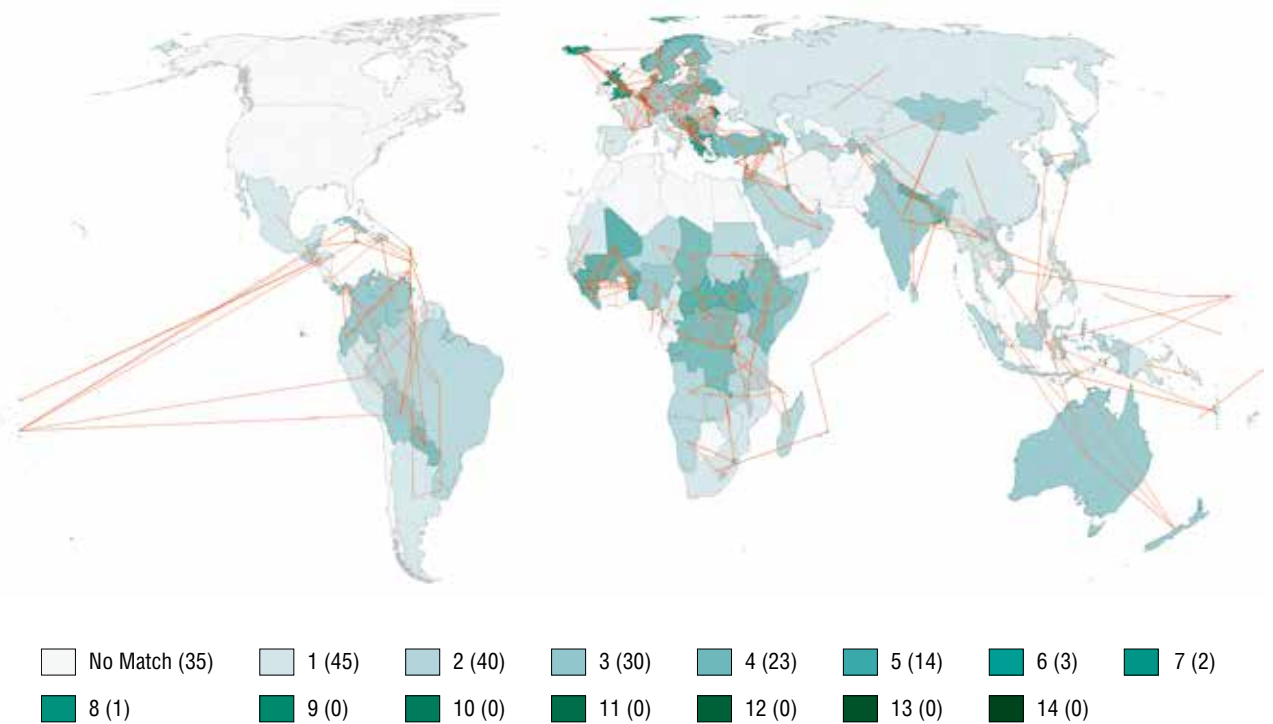


Fig. 10.5.2. Likelihood-ratio test for the “Internet users” indicator

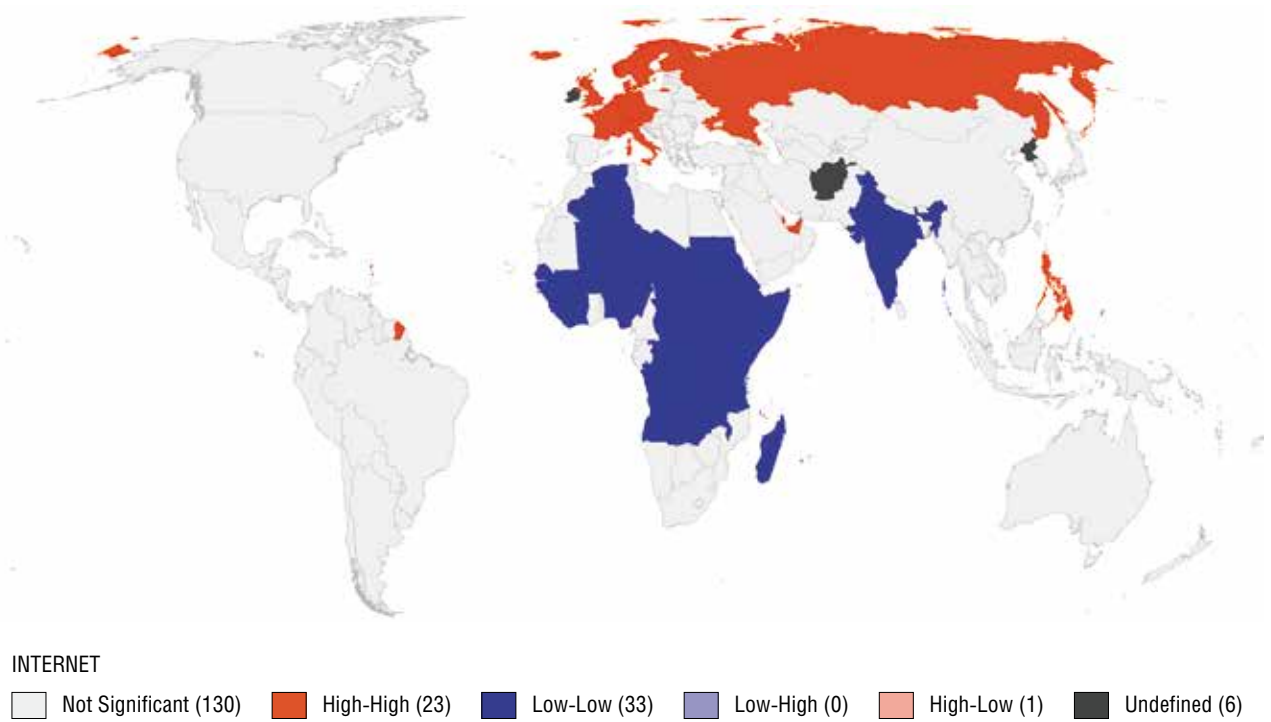


Fig. 10.5.3. “Internet users” spatial autocorrelation cartogram for the geometric neighbourhood matrix

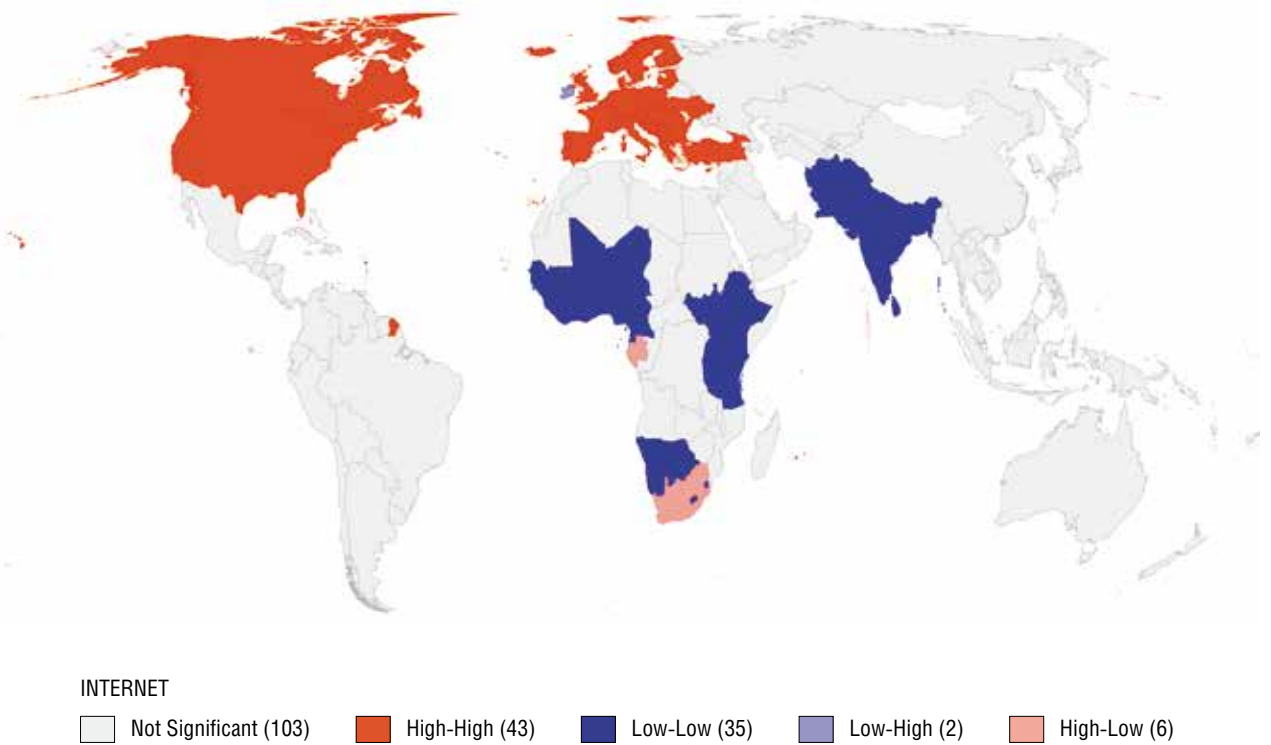


Fig. 10.5.4. “Internet users” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.6. Railway network

The “Railway network” indicator refers to the density of the railway network, which is calculated by dividing the total length of all the railway lines in the country (in km) by the area of its territory (in sq. km). An assessment of the role of space in determining the scores for this indicator gives us a moderate positive relationship for the geometric neighbourhood matrix and a weak positive relationship for the geopolitical neighbourhood matrix.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.463	0.000	0.261	0.000
Geary's C	0.544	0.000	0.734	0.000

The percentile cartogram (Fig. 10.6.1) shows high railway density in Japan, as well as in Europe, particularly in Germany and its neighbouring states — Switzerland, Denmark, Belgium, Austria, the Czech Republic and Slovakia. However, surprisingly, the small island nation of Saint Kitts and Nevis in the West Indies has the highest railway density in the world. Railways here are used mainly for industrial purposes — for transporting sugar cane from plantations. However, there are also narrow-gauge passenger lines that run around the coast of the islands.

The least developed rail network is in Paraguay. The country has a railway that connects it with neighbouring Argentina and Brazil, but priority in the development of transport has always been given to the construction of roads. The Philippines also suffers from an insufficiently dense railway network, a consequence of its location on an island archipelago where the construction of land routes between the islands is prohibitively expensive. The poorly developed railway network in Nepal can be explained by the country's mountainous terrain and the high number of hard-to-reach mountain settlements, where building a railway line presents a number of almost insurmountable challenges.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Global place	Country	Indicator (km of track per km ² of territory)
1	Saint Kitts and Nevis	191.6
2	Switzerland	142.3
3	Czech Republic	121.8
Mean (43)	(Albania)	24.95 (24.7)
Median (66)	(Dominican Republic)	10.05 (10.3)
129–130	Nepal, South Sudan	0.4
131	Philippines	0.3
132	Paraguay	0.1

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.6.3) gives us several significant clusters. First is a low-value cluster centred around Brazil, most likely due to the difficulties in railway construction, low population density and limited economic activity in the Amazon basin. Second is a low-value cluster in Africa that covers almost the entire continent. This is explained by the low population density and limited economic activity in North Africa (the Sahara Desert takes up much of the northern part of the continent), as well as by the poor economic development in the region and, consequently, the lack of funds for investing in railway construction — a true “vicious circle of poverty.” High-value clusters are located in the West Indies, where the relatively small countries make it easier to create a fairly dense railway network, and in Europe, where railways are one of the main modes of transportation due to the rapid development of railway construction during the period of Industrialization.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.6.4) gives us somewhat different clusters. While the low-value Latin American cluster (supplemented by Mexico) and the high-value European cluster are generally the same as those produced by the geometric matrix, a low-value cluster is observed in the countries of Northern Europe (Norway and Finland) and Canada, where railway construction is limited by geographical and demographic factors. At the same time, those NATO countries that are located more to the south formed a high-value cluster, which is perhaps explained by the fact that the geographic and climatic conditions in these states are more favourable for railway construction

The likelihood-ratio test for the “Railway network” indicator (Fig. 10.6.2) reveals the homogeneity of the European region and the states of Oceania, as well as Southern Africa. It is noteworthy that Canada is linked to Mexico and the Dominican Republic in terms of its railway development, while the United States does not have any neighbours at all. This observation allows us to conclude that railway development in the United States differs markedly from that of other countries in the Western Hemisphere due to economic and geographic factors.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Medium- and hi-tech sectors	0.0382	0	0.498	6.492251
2	Conservation areas	0.038	0.025	0.258	1.751684
3	Inbound tourism	0.041	0.028	0.257	1.610951
4	Cultural exports	0.037	0.048	0.238	1.530919
5	Urbanization	0.054	0.007	0.281	1.462241
6	Ethnic minorities	0.07	0.002	-0.277	1.096129
7	Availability of electricity	0.135	0	0.378	1.0584
8	Access to electricity	0.112	0	0.343	1.050438
9	Linguistic diversity	0.106	0	-0.318	0.954
10	Cultural solidarity	0.057	0.007	0.233	0.952439

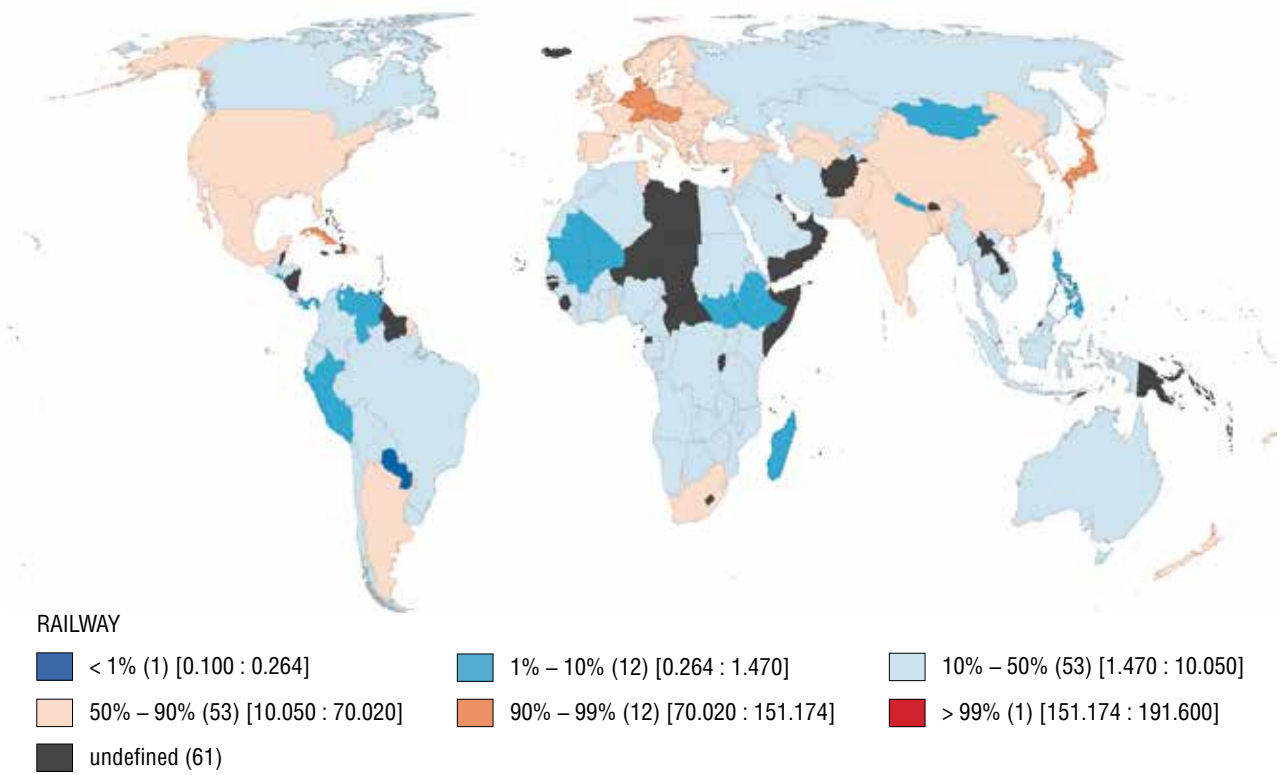


Fig. 10.6.1. Percentile cartogram for the “Railway network” indicator

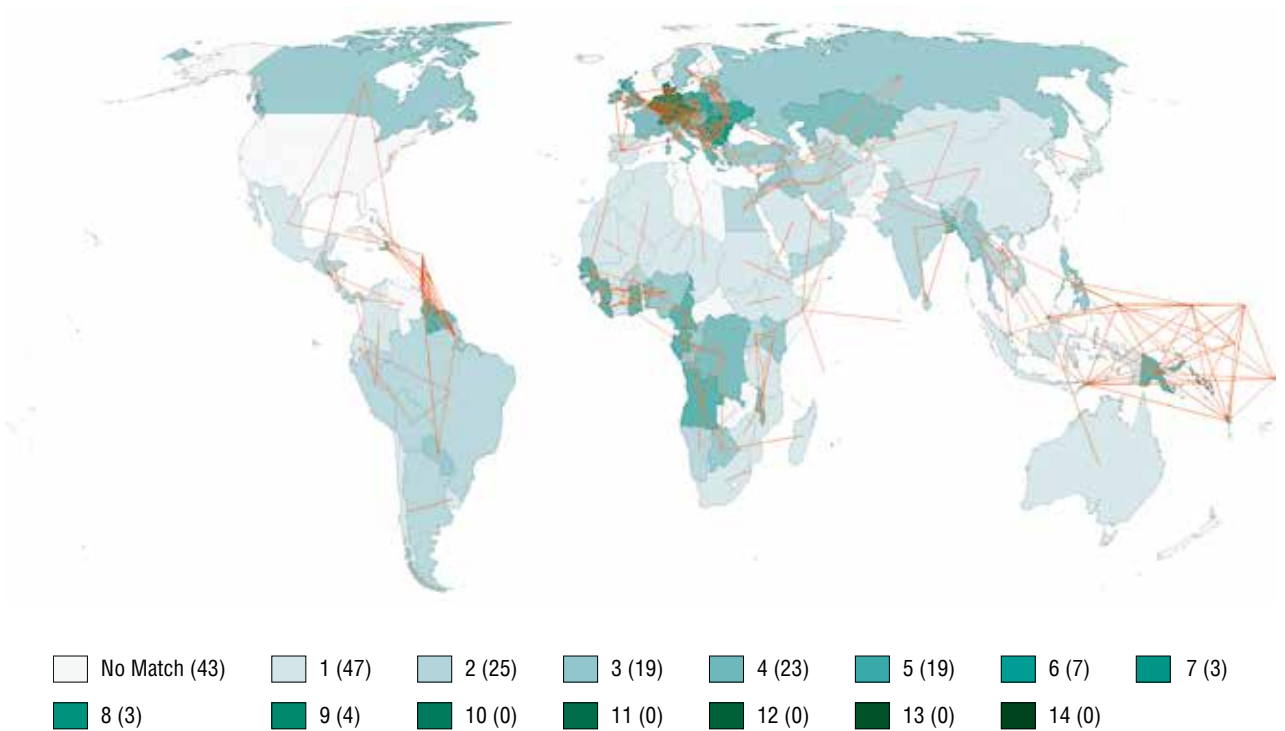


Fig. 10.6.2. Likelihood-ratio test for the “Railway network” indicator

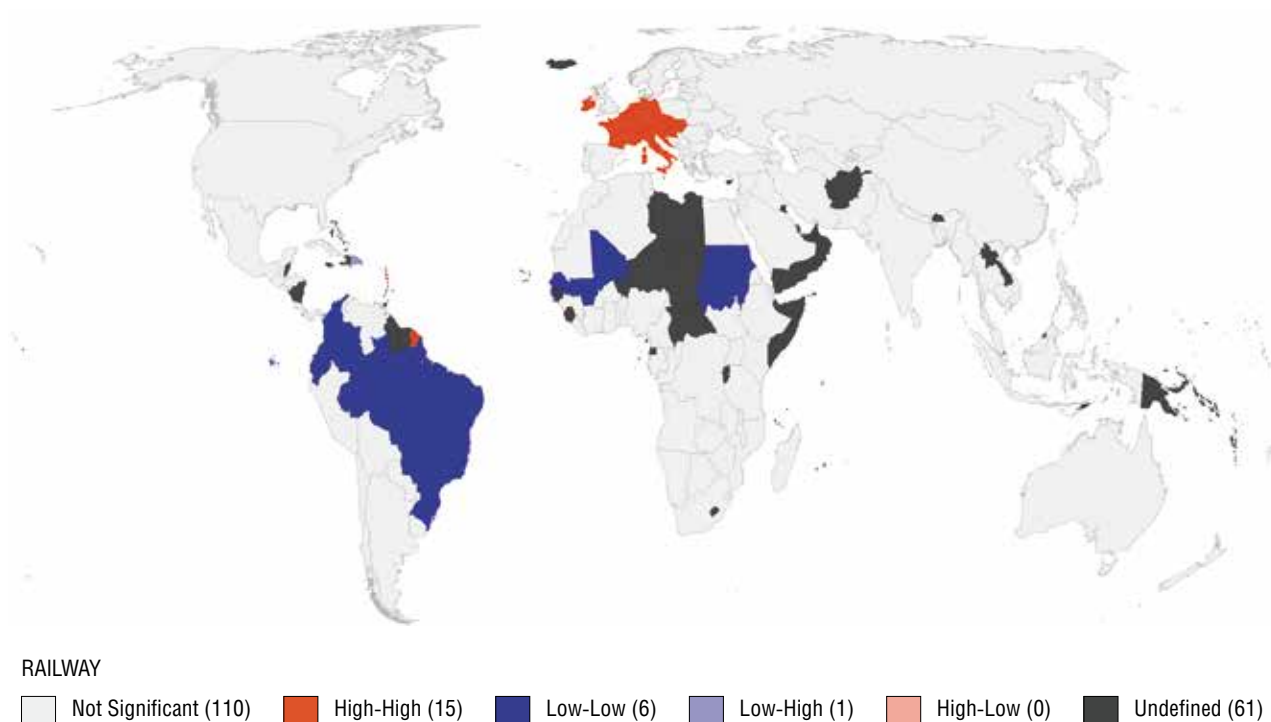


Fig. 10.6.3. “Railway network” spatial autocorrelation cartogram for the geometric neighbourhood matrix

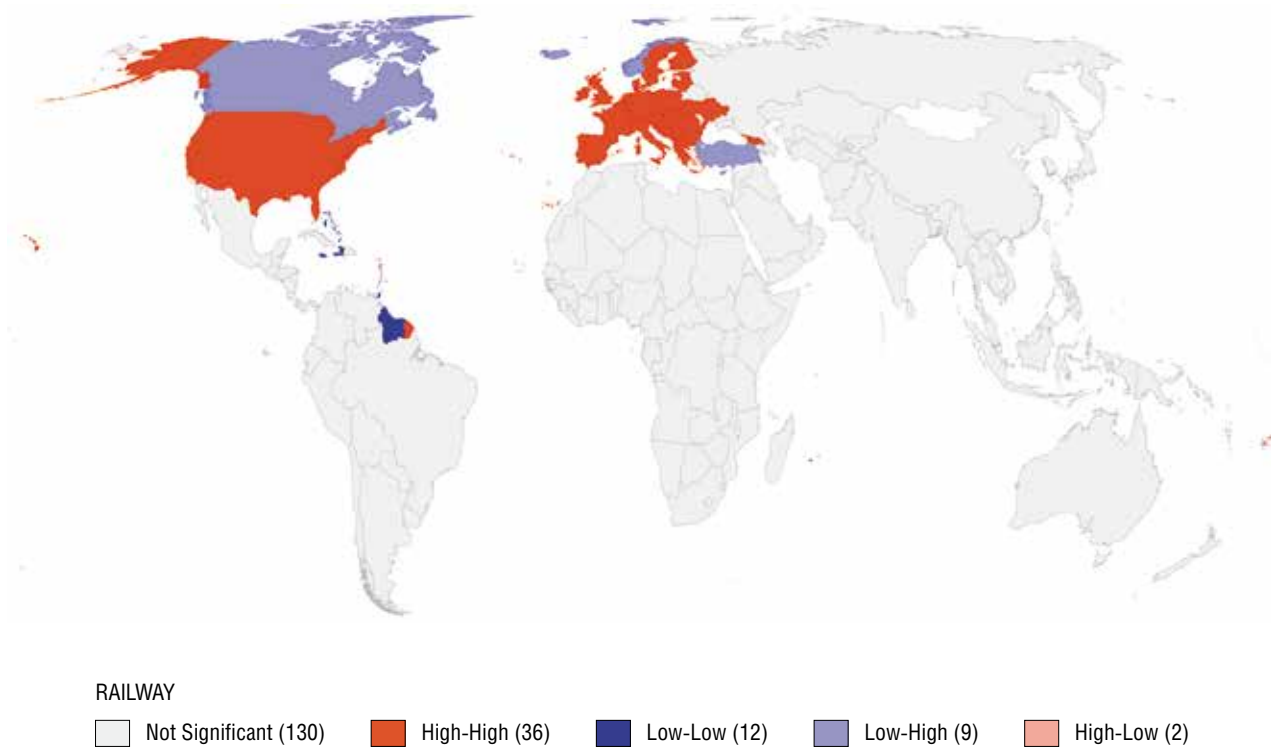


Fig. 10.6.4. “Railway network” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.7. Motorways

The “Motorways” indicator is a measure of the density of a given country’s road network and is calculated by dividing the total length of all roads in the country (in metres) by the area of its territory (in sq. km). An assessment of the role of space here reveals a moderate positive relationship for both the geometric and geopolitical neighbourhood matrices.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran’s I	0.098	0.000	0.052	0.001
Geary’s C	0.793	0.000	0.943	0.001

The percentile cartogram (Fig. 10.7.1) suggests that the world’s road network is relatively poorly developed. Countries that score high on this metric include those with a high population density, such as Japan, Belgium and Hungary. The leaders here are microstates, which makes it easier to provide road network coverage. The countries with the lowest scores on this indicator are African states with large desert areas and where there is practically no transport infrastructure.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world’s geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix gives us a number of large clusters. The high-value cluster includes the European region, excluding Spain and Portugal, a consequence of their delayed socioeconomic development during the period of Industrialization in the 18th–20th centuries compared to other European countries. Low-value clusters are apparent in two regions: the eastern part of Latin America, where road construction is difficult due to the unique ecosystem of the Amazon Basin; and almost all of Africa, where construction is hampered by the lack of financial resources and the desert terrain, resulting in low population density and patchy economic activity.

Global place	Country	Indicator (km of road per square km)
1	Monaco	38,118.8
2	Marshall Islands	11,204.4
3	Malta	9797.5
Mean (47)	(Tonga)	988.3 (948.4)
Median (96)	(Kenya)	279.5 (282.7)
190	South Sudan	10.9
191	Mauritania	10.3
192	Sudan	6.4

The results for the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.7.4) are slightly different: a high-value cluster within the Euro-Atlantic bloc, albeit with a large number of exceptions, most notably in Eastern Europe, as well as the United States and Canada. The low-value cluster that has formed in Eastern Europe is perhaps due to the predominance of rail transport compared to other European countries, and the low-value cluster in the United States and Canada is likely a result of the vastness of their territories, as well as the geographical characteristics of some U.S. states and Canadian provinces and the sparsely populated and uninhabited northern regions. Spain and Portugal find themselves in the European cluster, but Portugal, like Norway, the Balkan states and Turkey, are outliers here — while their neighbours scored highly on this indicator, they did not. The African cluster shifts to the north to include the Arabian Peninsula, where road construction is limited by the low population density and fragmented economic activity because of its desert location.

The likelihood-ratio test for the “Motorways” indicator (Fig. 10.7.2) speaks to the success of European integration programmes in terms of increasing the region’s transport connectivity, especially in the Scandinavian countries and the central part of the region. The road network in Southern Africa also appears to be fairly homogenous.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Healthcare spending	0.041	0.006	0.245	1.464024
2	Institutional foundations of democracy	0.049	0.002	0.194	0.768082
3	Access to electricity	0.028	0.02	0.14	0.7
4	Infant mortality	0.039	0.006	-0.163	0.681256
5	Passport power	0.071	0	0.202	0.574704
6	Publication activity	0.054	0.001	0.169	0.528907
7	Internet users	0.067	0	0.186	0.516358
8	Number of doctors	0.087	0	0.207	0.492517
9	Urbanization	0.053	0.001	0.128	0.309132
10	Renewable energy	0.027	0.024	-0,047	0.081815

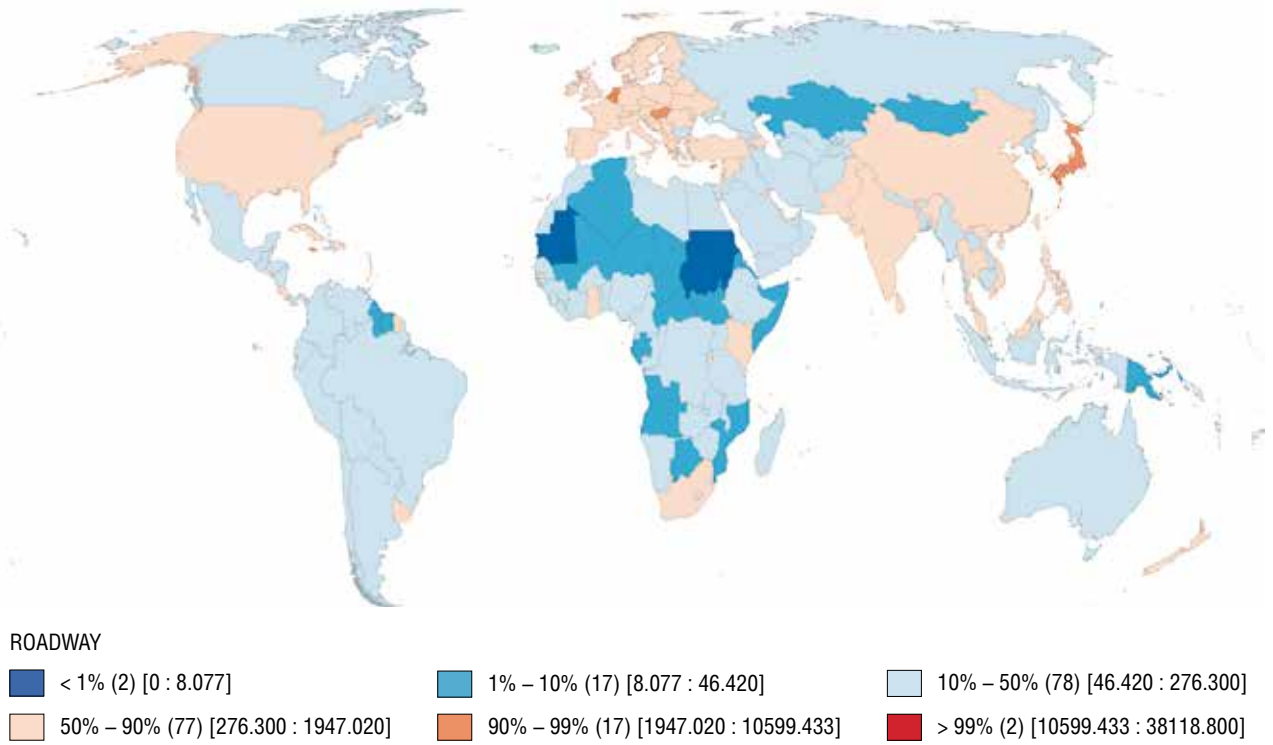


Fig. 10.7.1. Percentile cartogram for the “Motorways” indicator

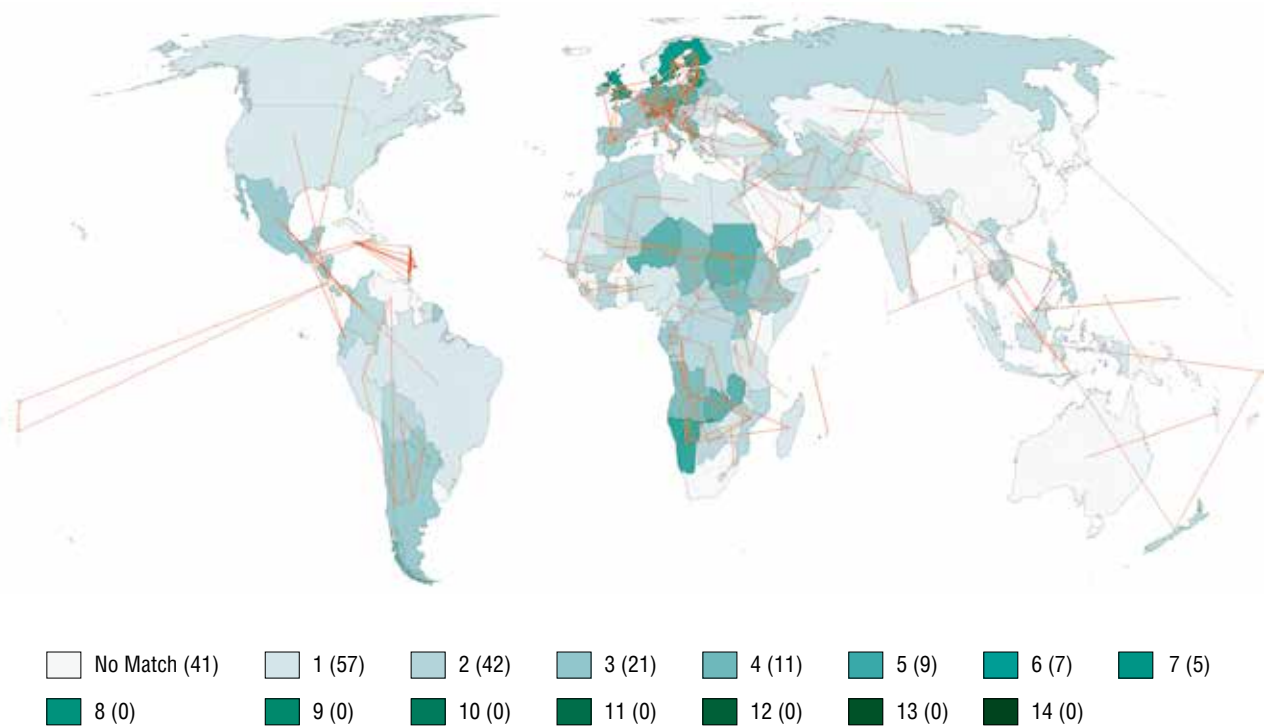


Fig. 10.7.2. Likelihood-ratio test for the “Motorways” indicator

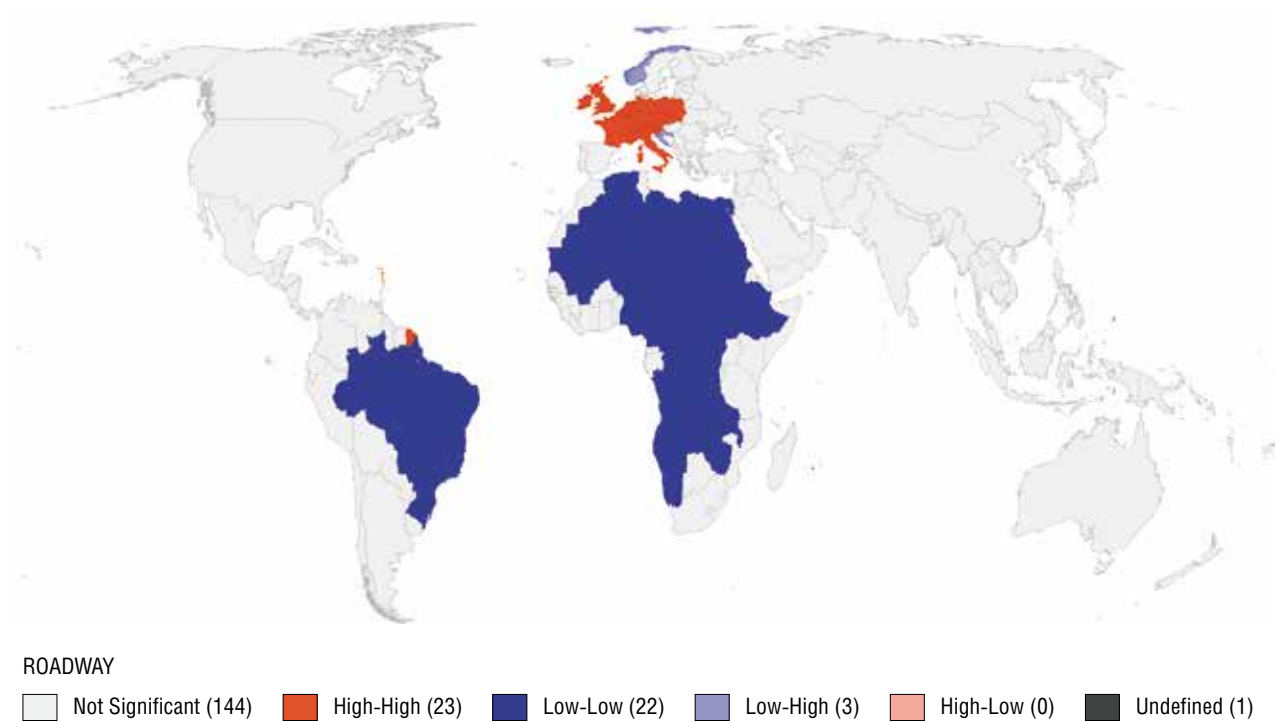


Fig. 10.7.3. “Motorways” spatial autocorrelation cartogram for the geometric neighbourhood matrix

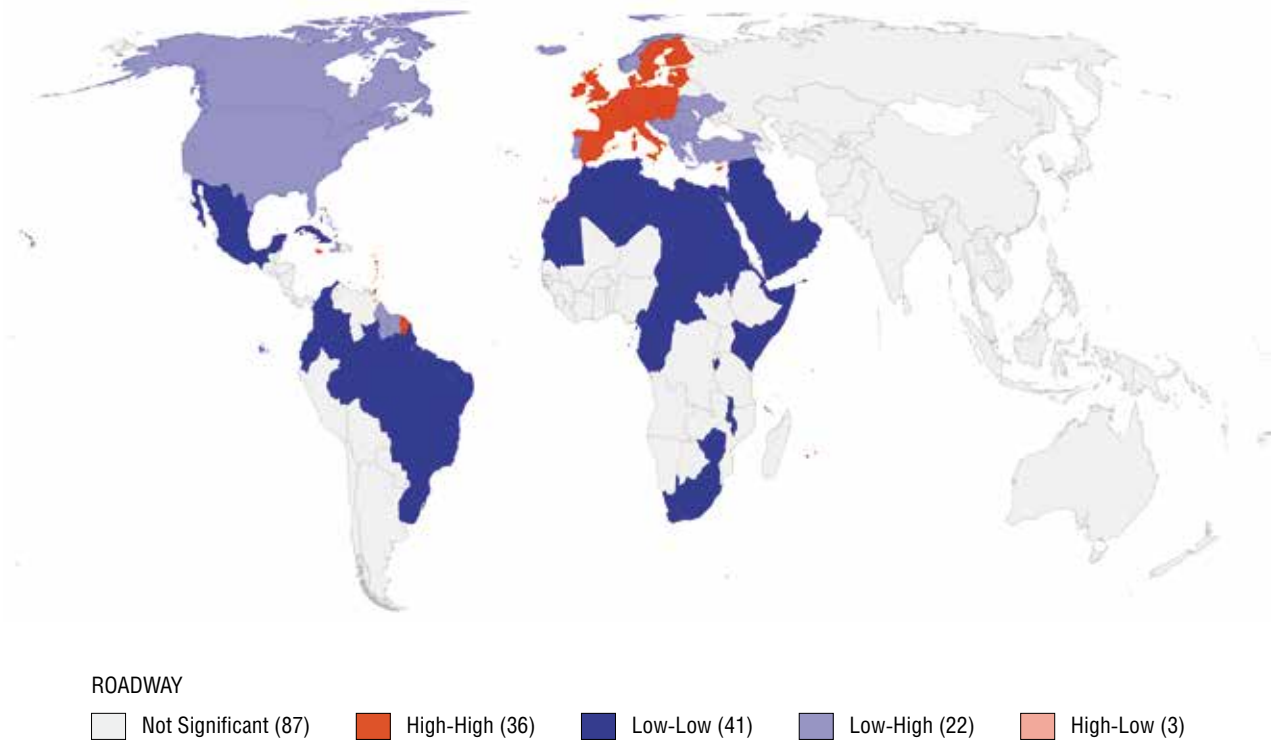


Fig. 10.7.4. “Motorways” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.8. Petrol prices

Petrol prices refers to the national average consumer price for motor gasoline in US dollars per litre. This is a necessary metric for measuring the availability of motor vehicles in a given country and, consequently, the frequency of their use, which indicates the level of development of the transport infrastructure. An assessment of the role of space in determining the scores for this indicator allows us to identify a moderate positive relationship for the geometric neighbourhood matrix and a weak positive relationship for the geopolitical neighbourhood matrix.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.345	0.000	0.186	0.000
Geary's C	0.646	0.000	0.810	0.000

The percentile cartogram in Fig. 10.8.1 indicates that petrol is cheapest in those regions that have a developed crude oil production infrastructure, such as Libya, where oil sales account for over 90% of the country's income from exports. Venezuela and Saudi Arabia are the world leaders in oil reserves, and petrol costs significantly less than one dollar per litre in these countries. Norway is an exception among the oil-producing countries, with gasoline costing almost USD 1.8 per litre. This is due to the high tax on oil production in the country, as well as the fact that Norwegian citizens receive significant benefits from oil sales.

Nowhere is petrol more expensive than in Eritrea, since the country does not have its own oil reserves, which means that it has to import raw materials at high costs, while most oil refineries need upgrading following the years-long civil war.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.8.3) reveals a high-value cluster in Western Europe, which is explained by the fact that there are no large oil fields in this

Global place	Country	Indicator (USD per litre)
1	Eritrea	2
2	Norway	1.78
3	Iceland	1.69
Mean, Median (82–84)	Angola, India, Congo	0.97
163	Saudi Arabia	0.24
164	Libya	0.11
165	Venezuela	0

region (with the exception of the North Sea). What is more, the European Union is switching to alternative energy sources and has introduced an environmental impact tax, thus leading to an increase in fuel prices. A significant (in terms of area) low-value cluster can be observed in Asia that covers the Arabian Peninsula and Central Asia, both of which are rich in crude oil, as well as in China, which has a developed oil industry of its own.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.8.4) yields significantly different results from the data on the geometric neighbourhood matrix. First, the GCC–LAS countries, many of which have active oil production, make up a low-value cluster, albeit with certain exceptions (Eritrea, Morocco, Mauritania, Somalia and Jordan). Second, a low-value cluster is formed by the members of the CSTO–EAEU–CIS bloc in Eurasia. The only exception here is Uzbekistan, where petrol prices are higher than in neighbouring countries.

The geopolitical neighbourhood matrix also shows that the Euro-Atlantic bloc forms a cluster of high petrol prices, as prices are affected by significant tax rates and duties. Outliers here are the United States and Canada, where fuel prices are relatively low (thanks to the fact that both countries satisfy domestic demand by extracting fuel themselves, which naturally reduces prices for domestic consumers), as well as Ukraine and Georgia, which import fuel resources from Russia at discounted prices.

The likelihood-ratio test for the “Petrol prices” indicator (Fig. 10.8.2) reveals several regions with similar indicator values: Europe and the Middle East, Oceania and Venezuela, which consistently boasts the largest, or near largest, oil reserves in the world.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Highly wealthy population	0.047	0.009	–0.212	0.956255
2	Years at school	0.03	0.027	0.164	0.896533
3	Hospital beds	0.07	0.009	0.244	0.850514
4	Particulate air pollution	0.103	0	–0.291	0.822146
5	Women in politics	0.072	0	0.242	0.813389
6	Internet users	0.026	0.041	0.14	0.753846
7	Children	0.038	0.013	–0.169	0.751605
8	Linguistic diversity	0.027	0.036	–0.142	0.746815
9	Number of doctors	0.082	0	0.242	0.714195
10	Economic inequality	0.033	0.03	–0.151	0.690939

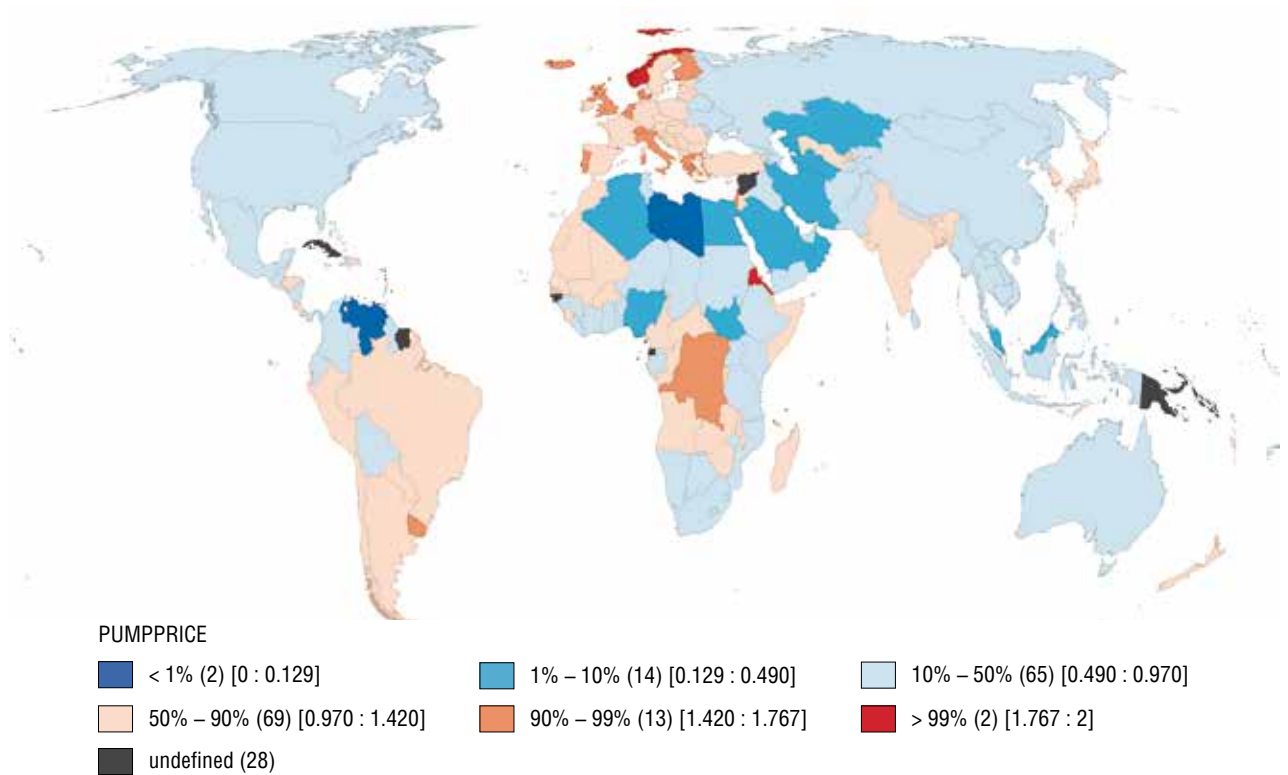


Fig. 10.8.1. Percentile cartogram for the “Petrol prices” indicator

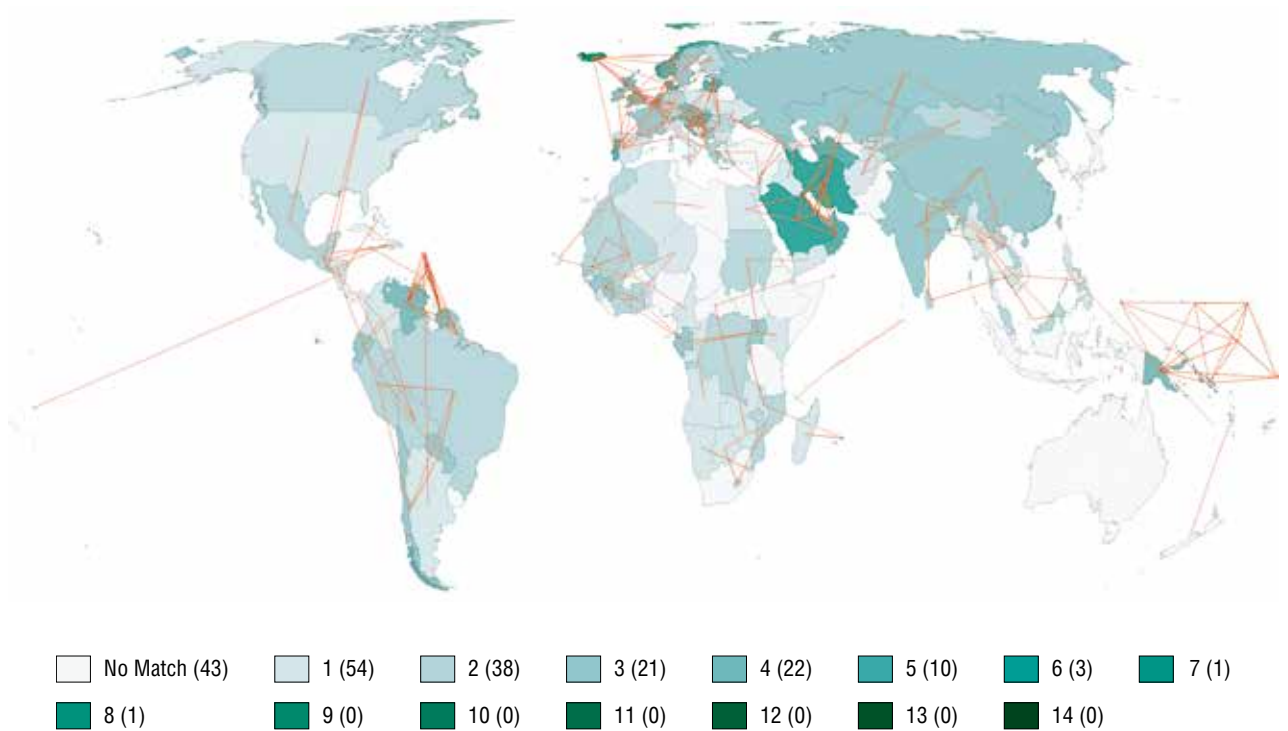


Fig. 10.8.2. Likelihood-ratio test for the “Petrol prices” indicator

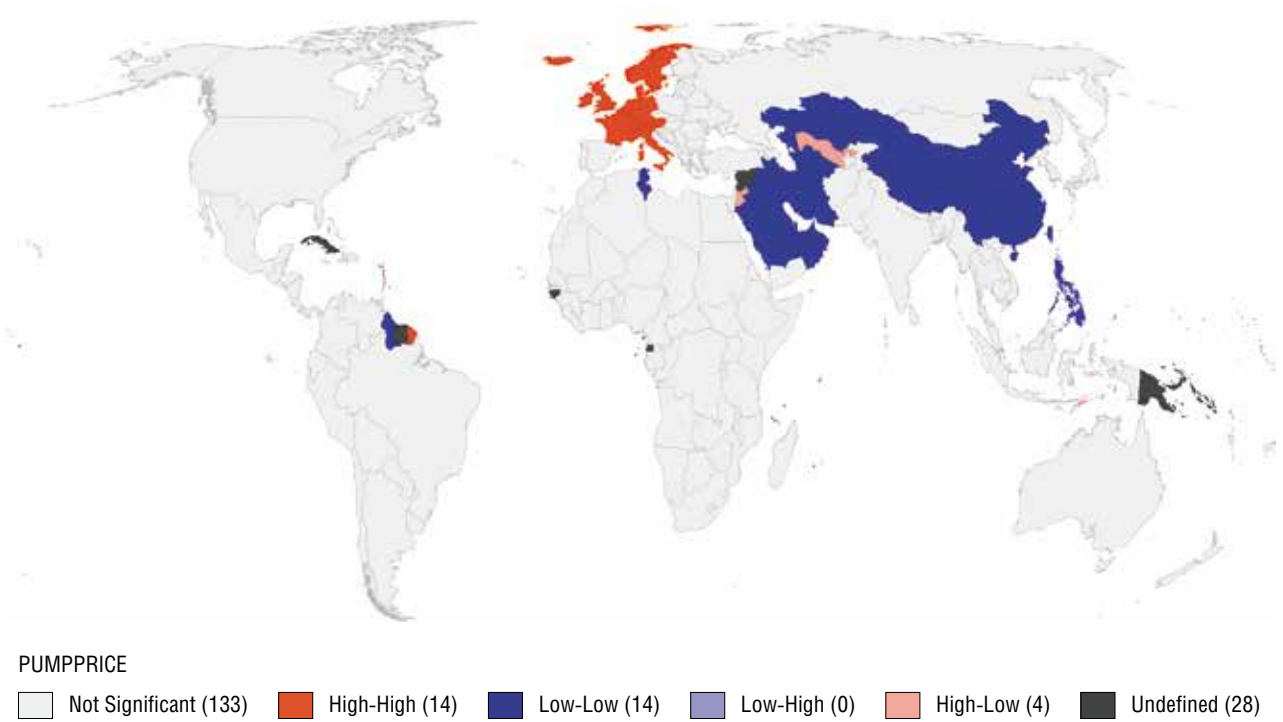


Fig. 10.8.3. “Petrol prices” spatial autocorrelation cartogram for the geometric neighbourhood matrix

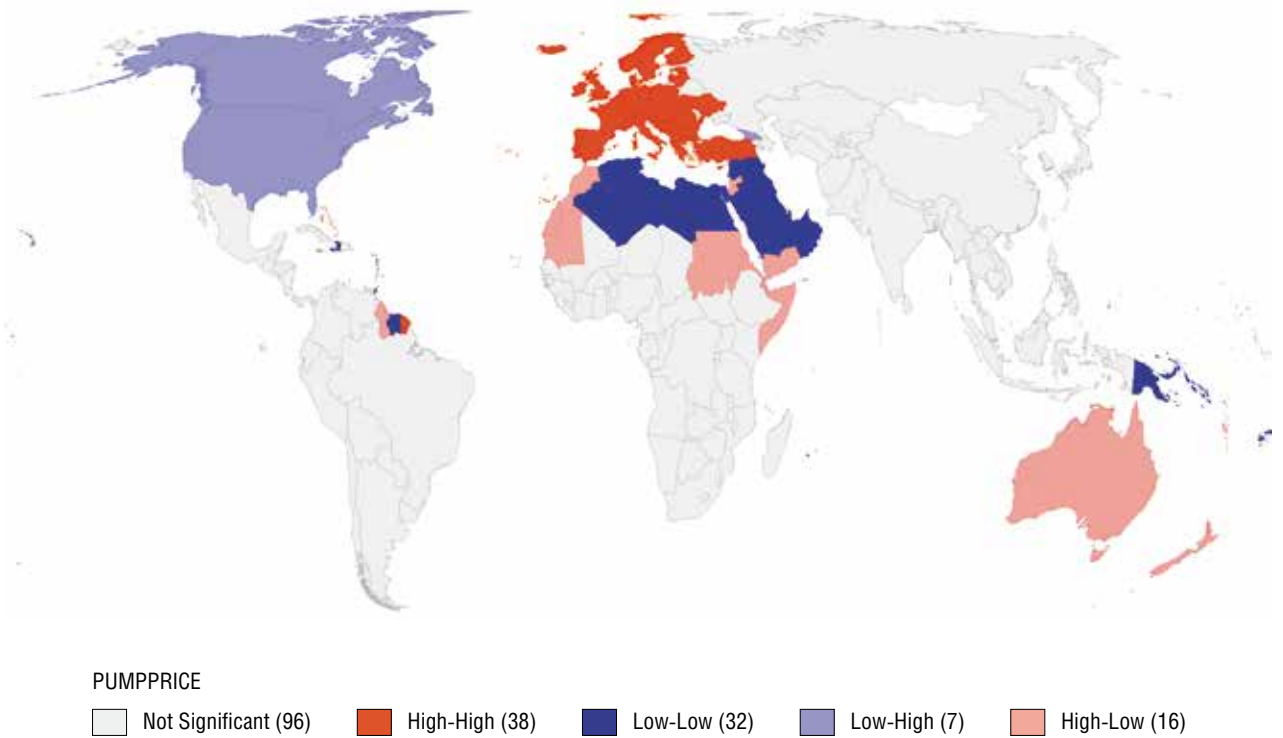


Fig. 10.8.4. “Petrol prices” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.9. Load on freight ports

“Load on freight ports” is understood as the total number of 20-foot containers unloaded at the country’s ports in the course of a year and is used to assess the workload of cargo ports and the readiness of the infrastructure to provide high freight mobility. An assessment of the role of space in determining the values for this indicator reveals a weak positive relationship.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran’s I	0.055	0.008	0.095	0.000
Geary’s C	1.857	1.000	0.901	0.000

Looking at the percentile cartogram (Fig. 10.9.1), we can see that China is the undisputed leader in freight shipping. The country has at least 20 major ports that can handle ocean shipping. China is also a leader in terms of commodity production, which adds to the already high load on freight ports. Second behind China is the United States, which benefits from the fact that it has access to two oceans — although the gap between the two is massive. Third is Singapore, whose port is among the busiest in the world, and second only to the Port of Shanghai in terms of commodity turnover. It is important to note here that this indicator does not include data for countries that do not have access to maritime shipping lanes, specifically the countries of Central Asia, Mongolia and some countries in Central Africa. Even so, the countries that appear at the bottom of the ranking do have access to the sea, but they are small in area and depend mostly on agricultural exports, rather than on goods shipped in containers.

The geometric neighbourhood matrix yields a lower spatial correlation than the geopolitical matrix, meaning that the hypothesis that the world’s geopolitical structure has greater significance is thus confirmed.

Global place	Country	Indicator (pcs per year)
1	China	21,668,4000
2	United States	52,132,844
3	Singapore	33,667,000
Mean (28)	(France)	5,598,545.9 (6,118,700)
Median (65)	Djibouti	928,000
127	Saint Kitts and Nevis	13,767
128	Equatorial Guinea	10,572
129	Dominica	8006

Both the spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.9.3) and the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.9.4) show a large high-value cluster in Southeast Asia that extends to the Indian and Pacific oceans. A notable outlier with low freight port traffic on both matrices is Cambodia, which relies more on inland transport than sea transport. Myanmar is also an outlier on the geopolitical neighbourhood matrix, as it has several seaports that are served primarily by Chinese and Japanese shipping companies.

The likelihood-ratio test for the “Load on freight ports” parameter (Fig. 10.9.2) also points to the homogeneity of the development of maritime freight shipping in Southeast Asia and Oceania. The relative homogeneity of the European region, and Southern Europe in particular, is also noteworthy. There is no apparent correspondence in the Western Hemisphere, which suggests that there are significant differences in the levels of development of shipping in the countries of North and South America.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Tax revenues	0.043	0.045	−0.142	0.46893
2	Children	0.036	0.032	−0.116	0.373778
3	Religious diversity	0.069	0.003	0.128	0.237449
4	Marriage	0.035	0.035	0.089	0.226314
5	Poverty	0.052	0.023	−0.103	0.204019
6	Medium- and hi-tech sectors	0.072	0.005	0.114	0.1805
7	Rate of gross accumulation	0.041	0.027	0.077	0.14461
8	Loans to domestic companies	0.133	0	0.121	0.110083
9	R&D spending	0.066	0.011	0.077	0.089833
10	Light pollution	0.308	0	0.131	0.055718

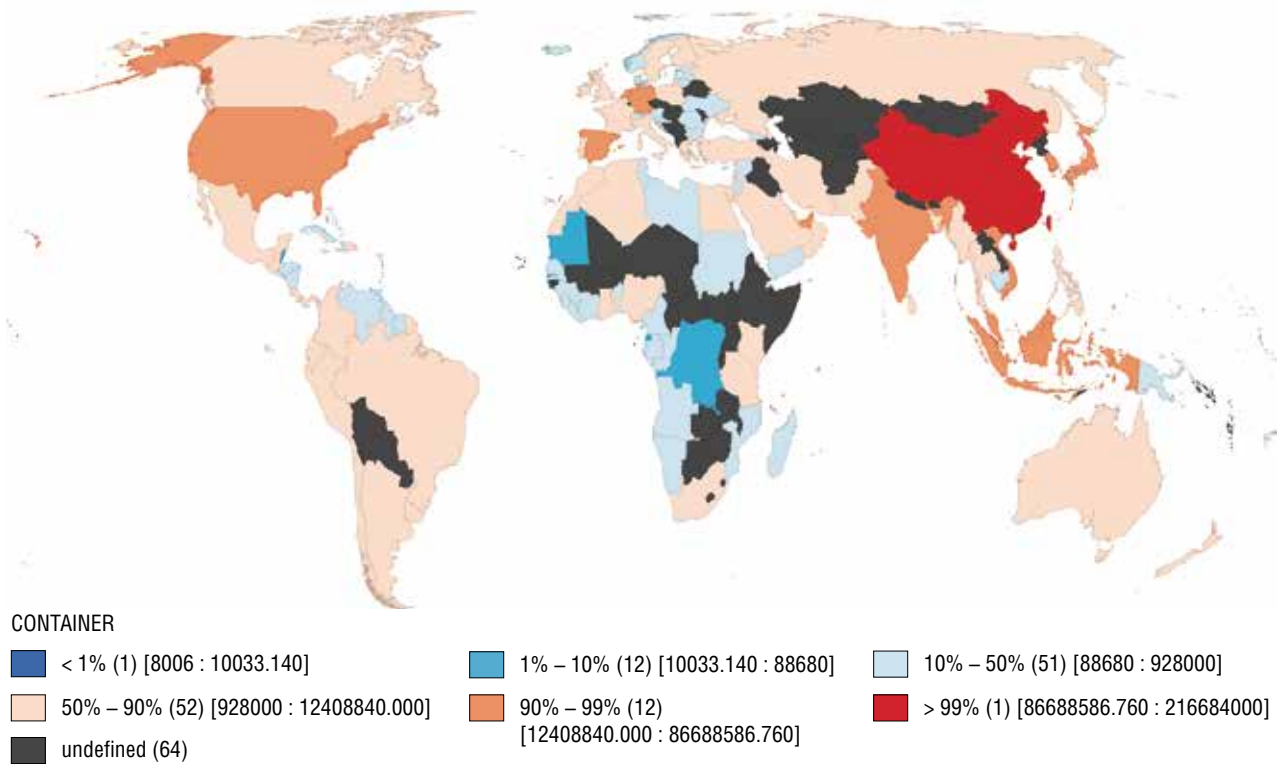


Fig. 10.9.1. Percentile cartogram for the “Load on freight ports” indicator

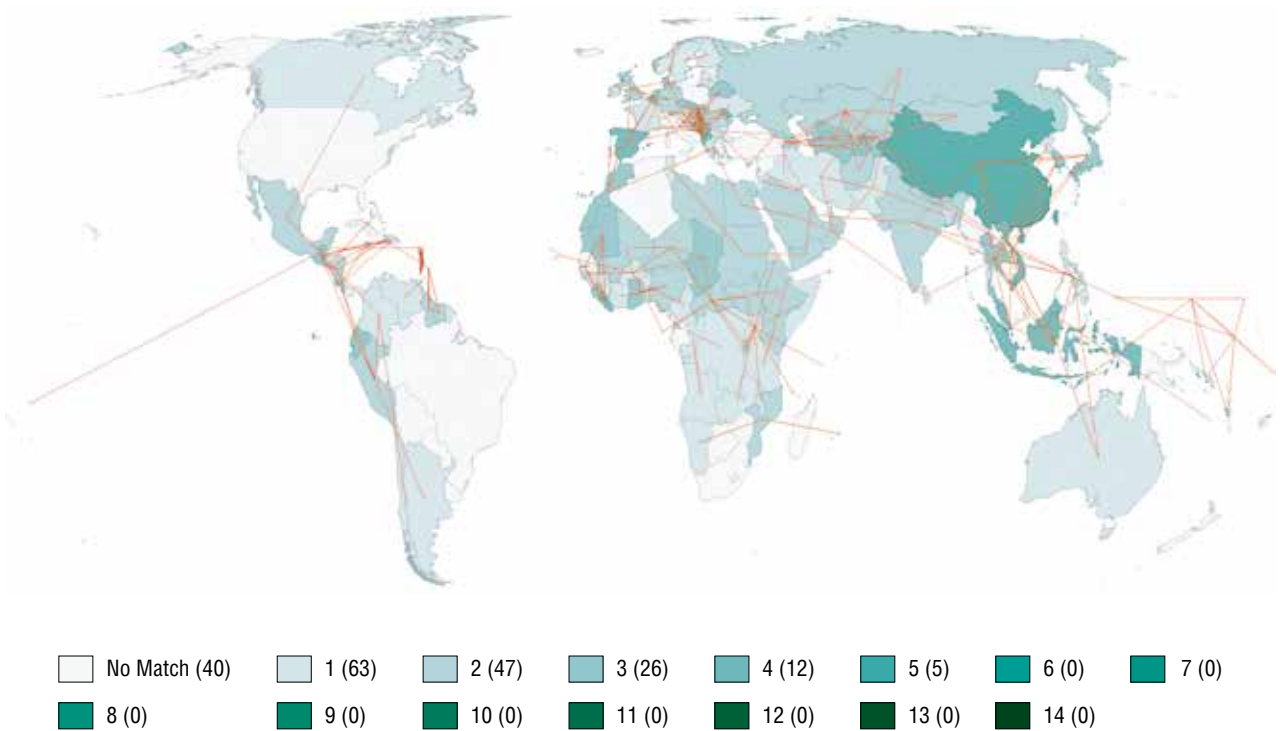


Fig. 10.9.2. Likelihood-ratio test for the “Load on freight ports” indicator

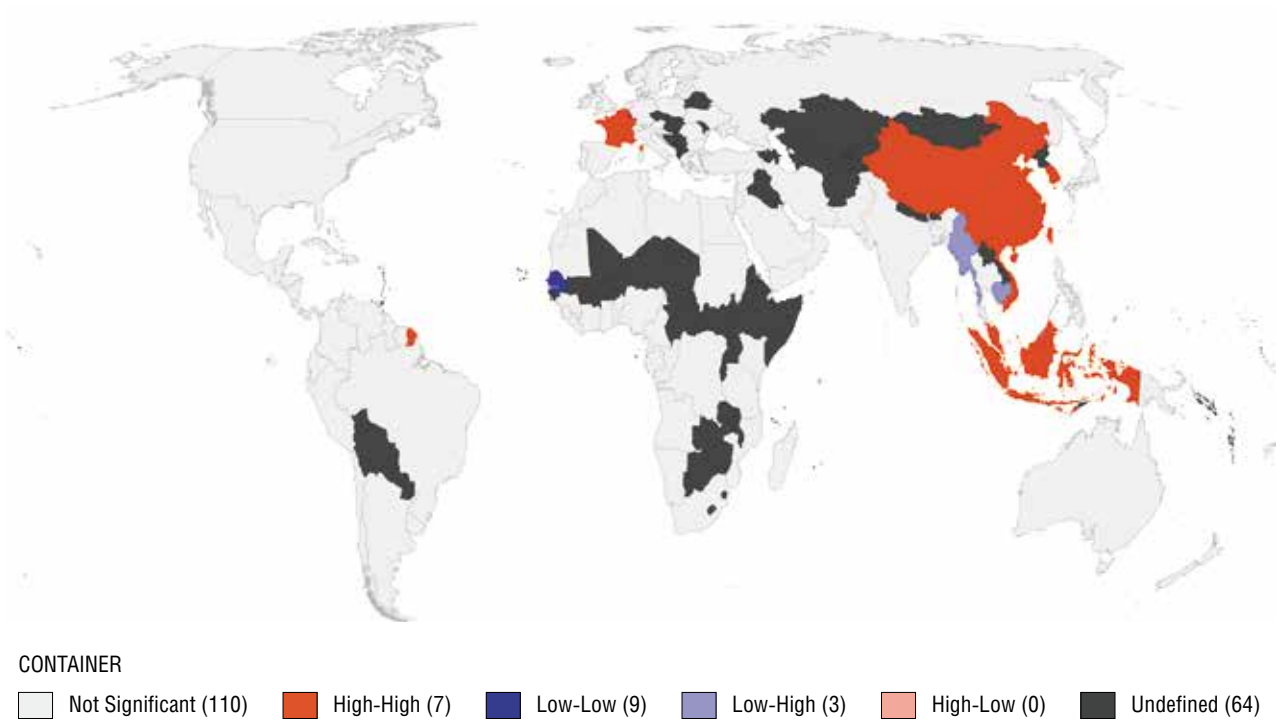


Fig. 10.9.3. “Load on freight ports” spatial autocorrelation cartogram for the geometric neighbourhood matrix

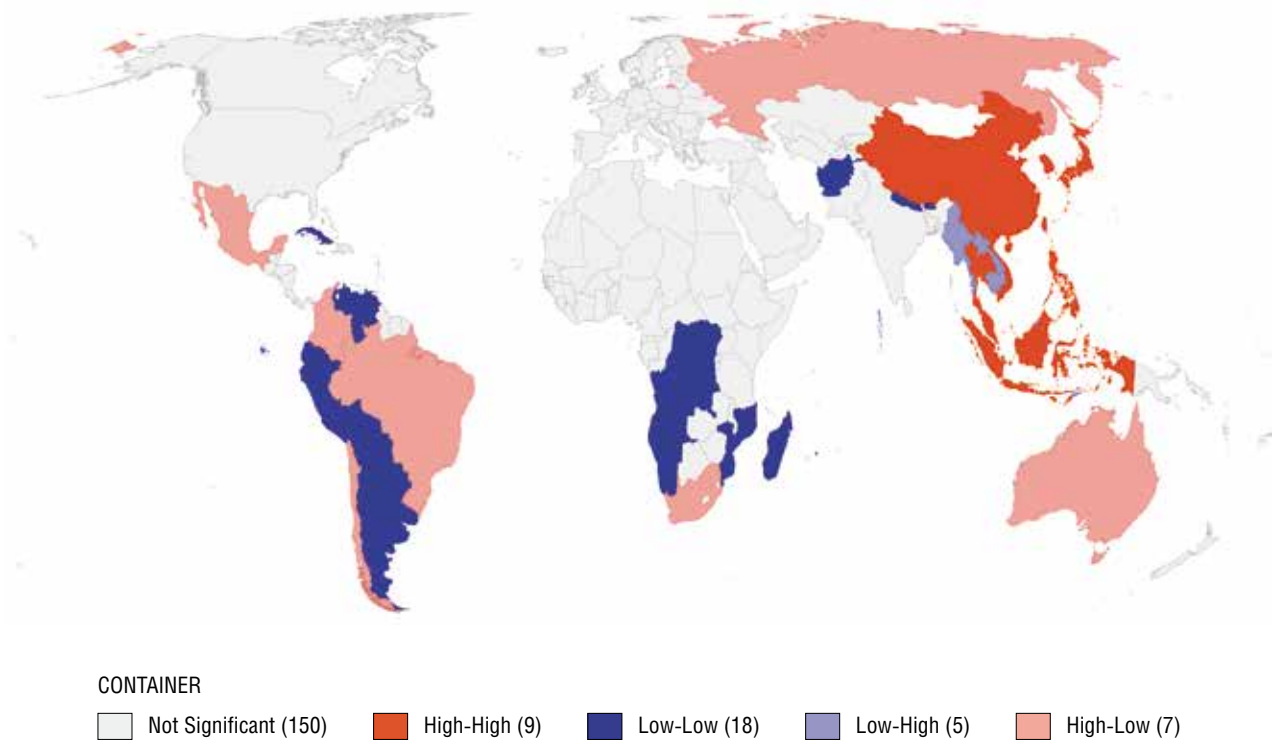


Fig. 10.9.4. “Load on freight ports” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.10. Air passengers

“Air passengers” refers to the total number of passengers carried on domestic and international flights by all registered commercial airlines over the past year. This indicator allows us to assess airport capacity and the state of the air traffic infrastructure. An assessment of the role that space plays in determining the values for this indicator reveals a weak positive relationship.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.099	0.002	0.045	0.013
Geary's C	1.056	0.651	0.950	0.013

The percentile cartogram (Fig. 10.10.1) shows that the United States and China are the clear leaders in terms of the number of air passengers. These are huge countries with record numbers of operating international airports. In addition, they both have massive populations, which has created a need for regular air services that are capable of carrying large numbers of passengers. In terms of the countries with the busiest airports, we should mention the United Kingdom, which is the main hub of international air traffic in Europe. On the other end of this scale are the airports of the poorest countries in Africa — Benin, Somalia and Malawi.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 10.10.3) highlights two large clusters: a high-value cluster that includes the United States, Canada and Mexico, and a low-value cluster that includes several sub-Saharan African countries: the Democratic Republic of the Congo, Tanzania, Zambia and Angola. As we can observe, the high-value cluster is mostly made up of countries with large territories, which explains why a network of regular, large-scale passenger air transportation is needed.

Global place	Country	Indicator (passengers per year)
1	United States	824,039,000
2	China	487,960,477
3	United Kingdom	143,781,714
Mean (29)	Switzerland	25 859 918
Median (77)	Afghanistan	1,917,924
151	Malawi	6744
152	Somalia	4486
153	Benin	899

Meanwhile, the appearance of the low-value cluster in Africa can be explained by the underdeveloped international tourism sector in the region, the Democratic Republic of the Congo's international isolation, and the relative poverty of the population of these countries, who cannot typically afford plane tickets.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 10.10.4) reveals a high-value cluster in East and Southeast Asia within the ASEAN+3 bloc, which is due to the fact that China, as well as other countries with a high population density and relatively high incomes (primarily Japan and South Korea), are members of that grouping. Exceptions in this cluster include Myanmar, Laos and Cambodia, which are not air transport hubs and do not possess the necessary infrastructure to support a heavy flow of air travel and serve large numbers of air passengers.

Particularly noteworthy is the division of the Euro-Atlantic bloc into western and eastern parts, with air passenger traffic being low in the east and the west, despite its proximity to the east, having a large concentration of "outliers," where air passenger flows are high.

The likelihood-ratio test for the "Air passengers" indicator (Fig. 10.10.2) provides us with an idea of what European integration looks like, with air traffic developing uniformly in the region. We should also note the similar scores obtained by neighbouring countries in sub-Saharan Africa, Latin America, Southeast Asia and Oceania. No significant relationships were found in North America, which points to a differentiation in the number of air passengers in this region.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Bioethical freedom	0.057	0.005	0.182	0.581123
2	Quality of school education	0.062	0.003	0.179	0.51679
3	Number of researchers	0.06	0.012	0.159	0.42135
4	Internet users	0.043	0.011	0.131	0.399093
5	Years at school	0.042	0.013	0.129	0.396214
6	Infant mortality	0.035	0.021	-0.115	0.377857
7	Children	0.049	0.007	-0.132	0.355592
8	Life expectancy	0.046	0.008	0.125	0.339674
9	Urbanization	0.027	0.043	0.09	0.3
10	GDP (PPP) per capita	0.068	0.001	0.138	0.280059

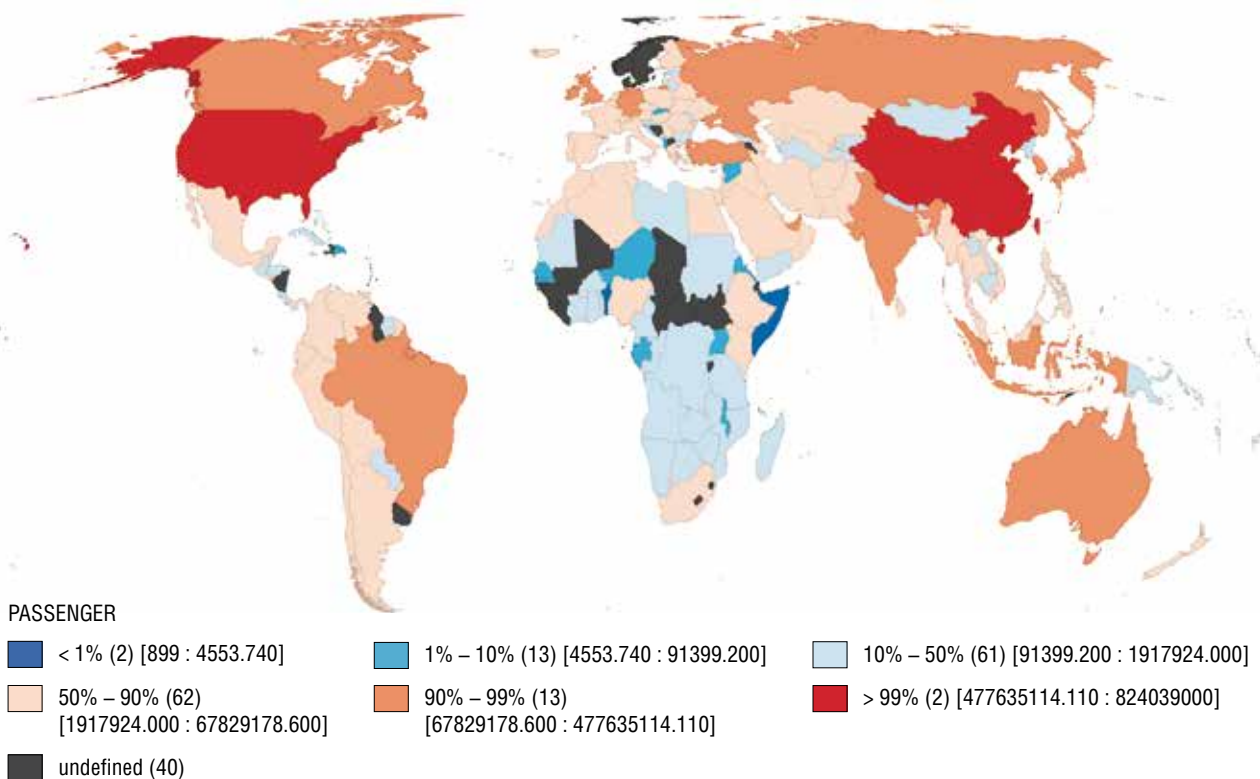


Fig. 10.10.1. Percentile cartogram for the “Air passengers” indicator

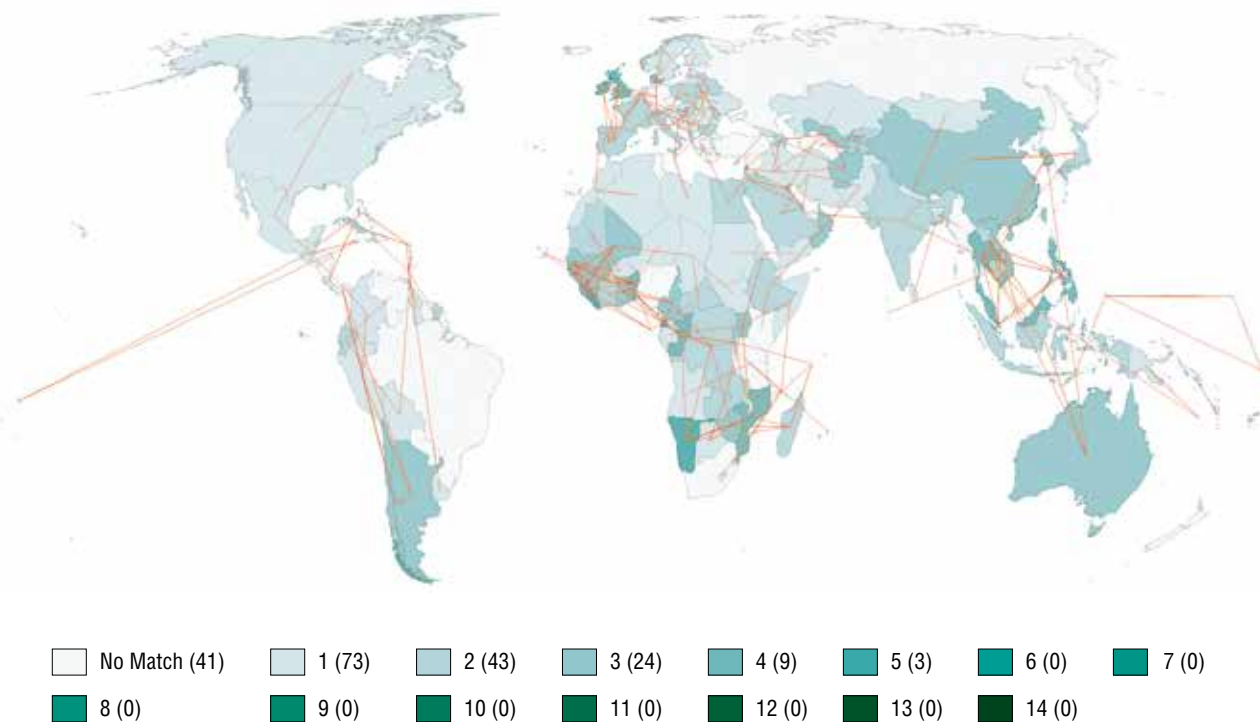


Fig. 10.10.2. Likelihood-ratio test for the “Air passengers” indicator

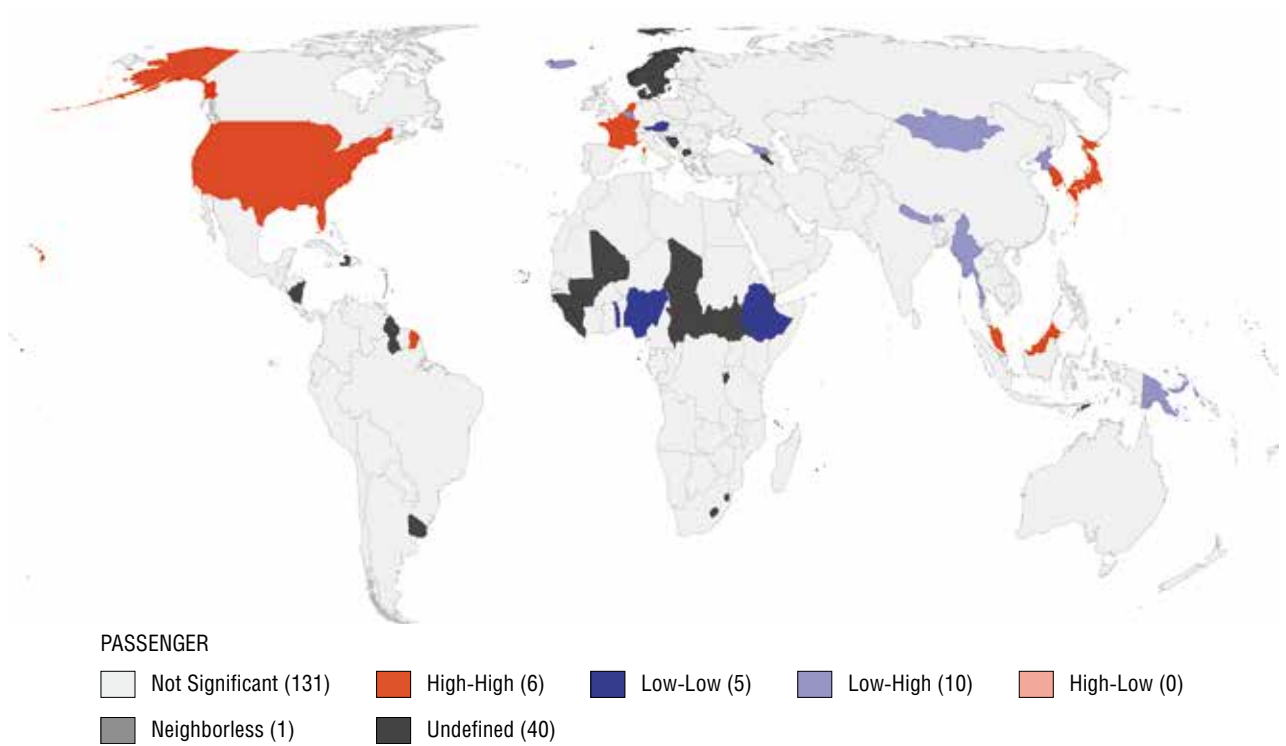


Fig. 10.10.3. “Air passengers” spatial autocorrelation cartogram for the geometric neighbourhood matrix

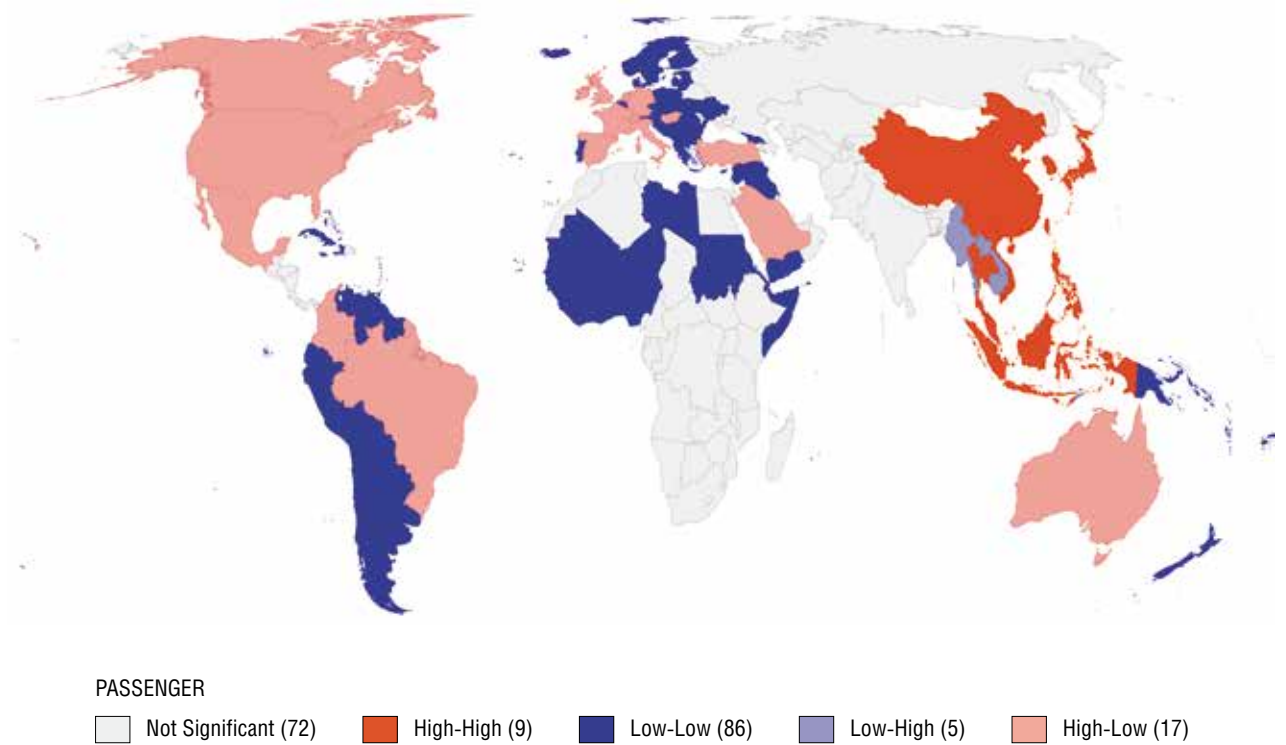


Fig. 10.10.4. “Air passengers” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

10.11. Multifactor analysis of the “Mobility” section indicators

The next logical stage in assessing mobility is to analyse the entire group of relevant indicators as a whole.

The most telling factors for the “Mobility” section concern the spatial distribution of the geographic average for the load on freight ports, the number of air passengers, and the density of the road network. The geographic average ellipses have a slight slope along the United States — China axis. In terms of the proportions of the ellipses, their geometric dimensions (major and minor axes) are approximately equal.

The geographic average for the “Air passengers” indicator is skewed to the north. Its shape is affected by the concentration of high values in a number of European countries, as well as by the influence of non-European “centres of attraction” of passenger traffic, such as Indonesia, Brazil and Australia, and the dominance of the United States in this indicator. A pattern is observed here — countries with large populations are often among those with a high number of passengers. Ireland is an exception here, as the score depends on where European airlines are registered.

The geographic average for the “Motorways” indicator is due to the high density of the road network in relatively small European countries. The slight bias of the geographic average to the east is down to the figures for small countries and island states outside Europe (in the Caribbean and Oceania).

The geographic average for the “Load on freight ports” indicator is elongated towards China, a result of its relative dominance in this indicator. Southeast Asia offers up more countries that are among the leaders here, namely Singapore, South Korea and Malaysia. Most landlocked countries did not receive a score for this indicator, although there is data on the shipment of containers from Switzerland and Austria, for example.

Our analysis of the geopolitical space reveals significant shifts in the spatial distribution of the “centres” of container traffic and petrol prices in a number of regional political and economic integration alliances in terms of geographic average. The strongest difference in ellipses was noted in Western Europe and North America, due to the influence of the United States when it comes to container shipments compared to the countries of Europe, including those that are landlocked. The geographic average of petrol prices falls on Europe. This can be explained by the fact that Europe is home to a high concentration of countries, as well as by the fact that fuel costs do not express a great degree of variance around the world (there are no influential observations here). The southward shift in petrol prices in the Arab League bloc is linked to the influential observations of Eritrea and Djibouti. And the bias to the north of the container shipping centre in MERCOSUR is associated with the high scores obtained by Brazil and Mexico.

Four large clusters can be identified using the Multifactor Geary’s C based on the geometric neighbourhood matrix. These can provisionally be designated as an African cluster, a South American cluster, a Central European cluster (where countries demonstrate similar results to their neighbours), and a North and Central Asian cluster that features Afghanistan and Mongolia — the most atypical for the de facto “post-Soviet” cluster (which includes states that do not display similarities with their neighbours). At the same time, it is difficult to identify any clusters in North America or Southeast Asia (Thailand, Vietnam, Laos and Myanmar), since these macro- and meso-regions, respectively, are interspersed with countries that demonstrate different spatial effects.

In the context of the geopolitical neighbourhood matrix, implementing this method allows us to talk about several clusters whose countries demonstrate a high level of congruence. Africa, MERCOSUR and the NATO countries stand out in this respect. Some Arab League countries — specifically the most centrally located members of the bloc (Saudi Arabia, Iraq and Oman) — can also be regarded as a cluster of countries that is similar to its neighbours.

There is a noticeable change between the cartogram where the geographical factor is of absolute importance and the cluster analysis cartogram non-adjusted for geographic proximity, particularly in Europe to the west of Russia: a global division along the Western Europe — Eastern Europe axis (except

for Ireland and Portugal on the west and Ukraine, Bosnia and Herzegovina on the east) turns into a North–South division of Europe.

Serious changes are also taking place in South America, Central Asia, and Africa, where the “patchwork quilt” is being replaced by something similar to meso-regional differentiation. The most pronounced cluster is in Central Africa, which is joined by Afghanistan, Madagascar, Laos, and North Korea.

The smallest changes are observed in Southeast Asia: Thailand, the Philippines and Cambodia were assigned to different clusters.

In North America, the changes affected Canada, which was placed in the Northern European cluster when adjusted for geographic proximity, and, when not adjusted for geographic proximity, was merged with the cluster formed by the main global actors, the United States, China, South Africa, Turkey, Brazil, India and Australia.

The main change on the cartogram, which places equal emphasis on the geographic and statistical factors, is the appearance of meso-regionality. However, the borders of the mesoregions are very different from the ones found on the other two cartograms.

This is particularly noticeable for Africa. The most stable cluster is the one that has formed in North Africa and the Middle East. The absolute geographic factor adds Turkey and Israel to this grouping.

If we combine the statistical and geographic factors, then an extensive cluster is formed in East and Southeast Asia that includes Indonesia, China, South Korea, Thailand, Japan and Australia. The South Asian cluster, where the geographic and statistical factors have equal impact, includes Mongolia and Pakistan, which switch clusters.

Two countries stand out in South America from the absolute geographic factor — Ecuador and Guyana, which will join the cluster of Venezuela, Columbia and Suriname.

In Eurasia, Russia and Kazakhstan are part of the cluster that will include the post-Soviet Republics of the Caucasus and Central Asia, as well as Afghanistan and Mongolia.

Australia will join the cluster of New Zealand and Papua New Guinea.

On the scatter plot, the superpowers United States and China are marked as individual points at a distance from the main cloud, with China located farther from all observations. The sparsely populated left part of the cloud (the second quadrant) is made up of developed and fledgling European democracies, as well as Argentina, China, Japan and South Korea. The third quadrant includes such developing countries as Russia, Brazil, Mexico, India, Canada and Spain. The right end of the cloud contains island countries (Palau and Nauru) and failed states (Somalia and South Sudan). African countries are mostly located along the boundary between the first and fourth quadrants, while the boundary between the first and second quadrants is populated by the countries of South and Central America and the Caribbean.

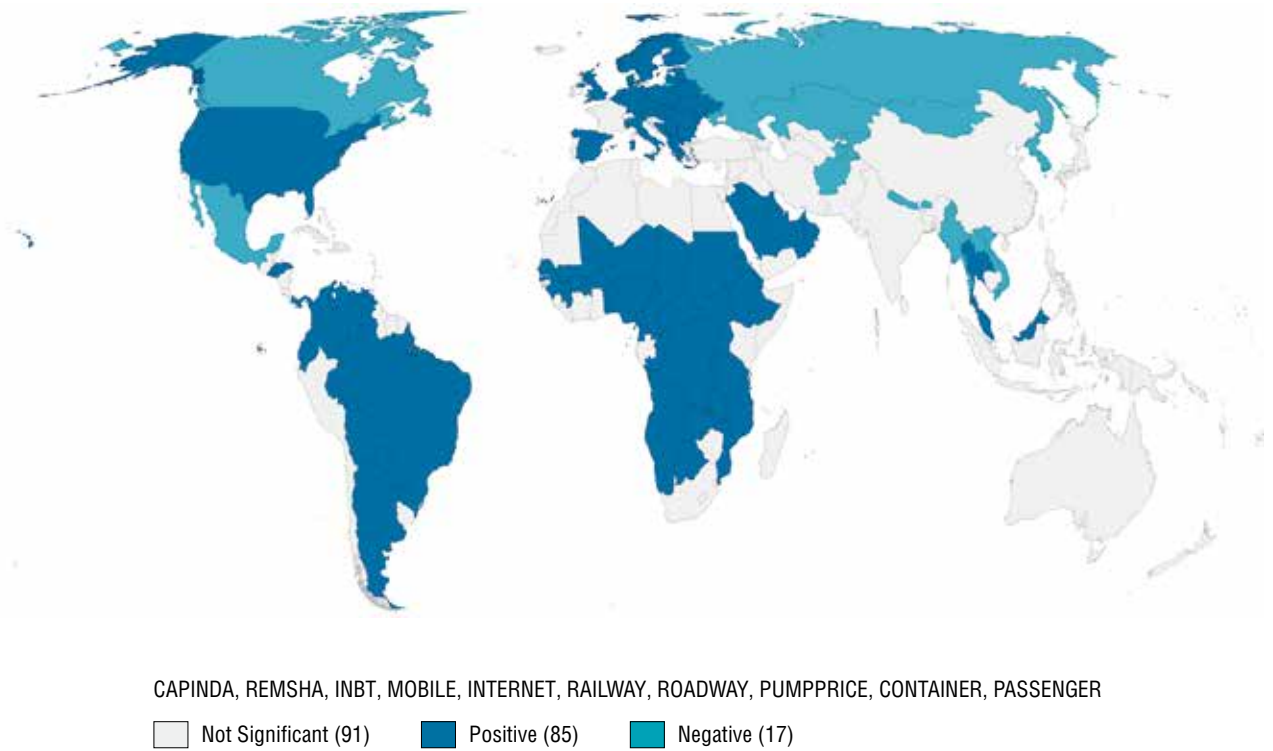


Fig. 10.11.1. “Mobility” Spatial autocorrelation cartogram for the geometric neighbourhood matrix

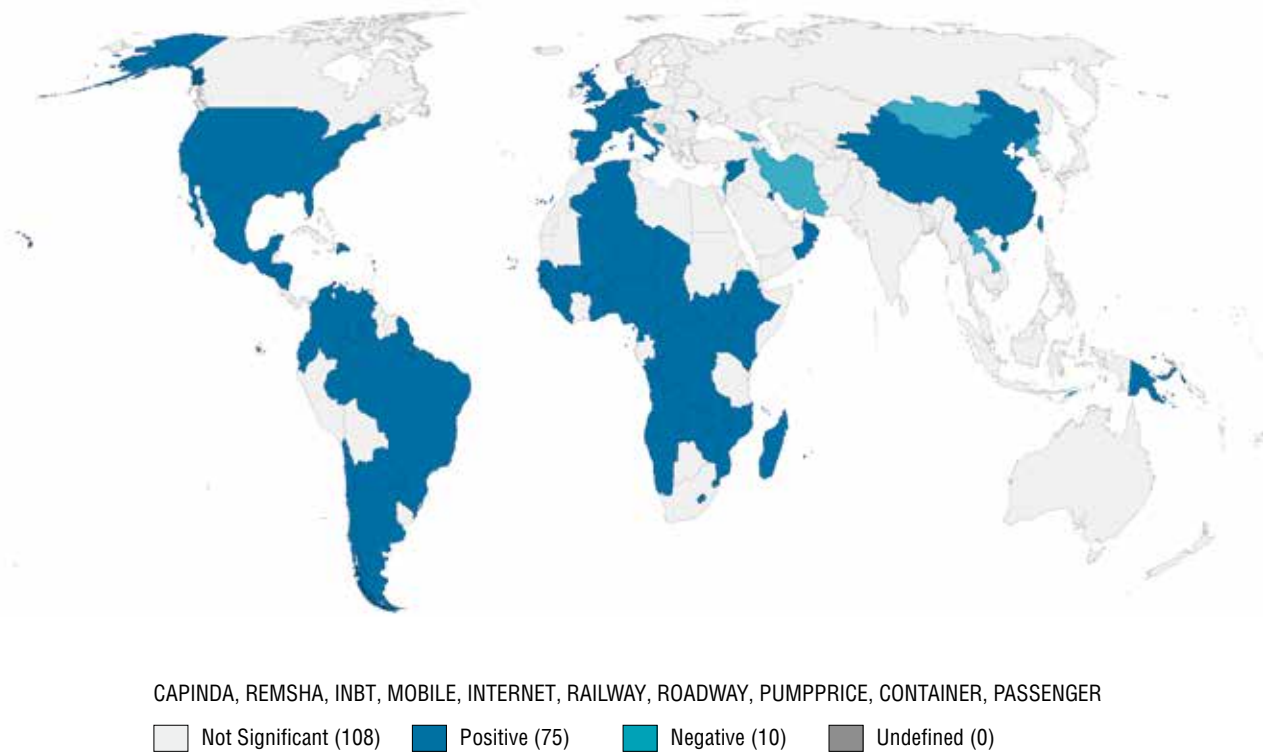


Fig. 10.11.2. “Mobility” Spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

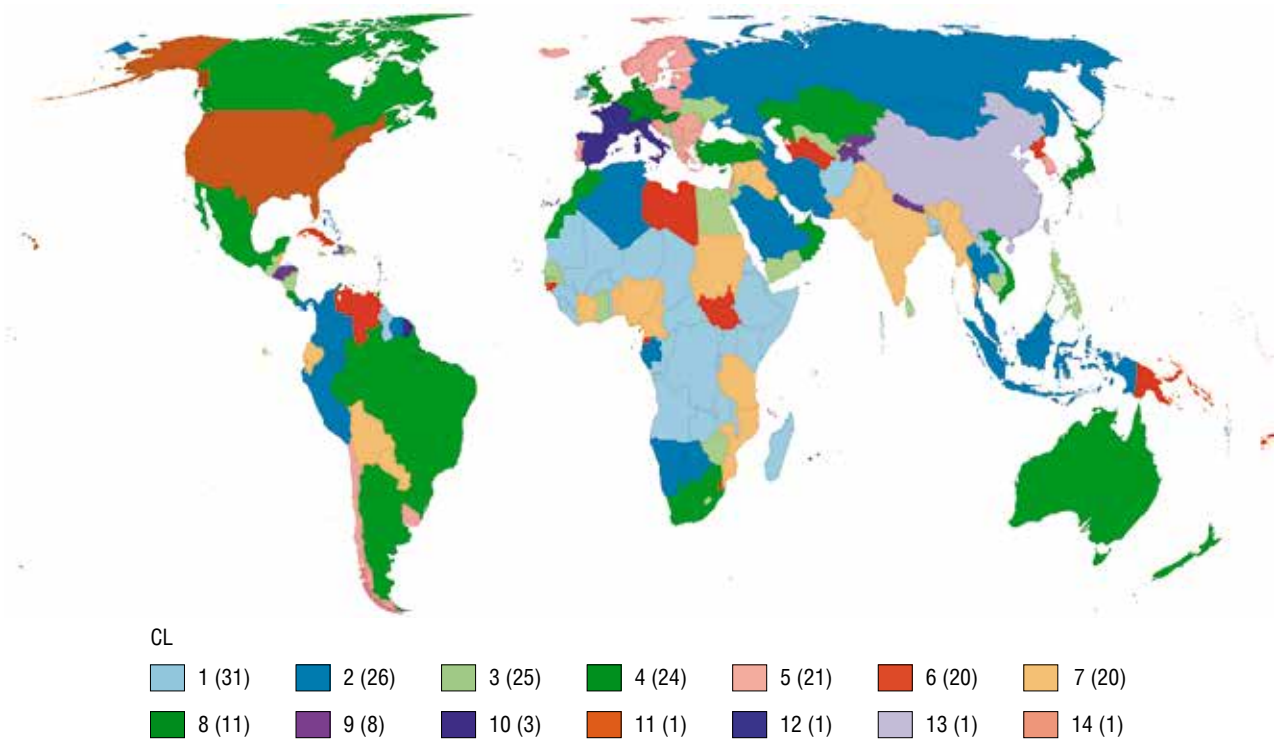


Fig. 10.11.3. Statistical clusters cartogram for the "Mobility" section indicators

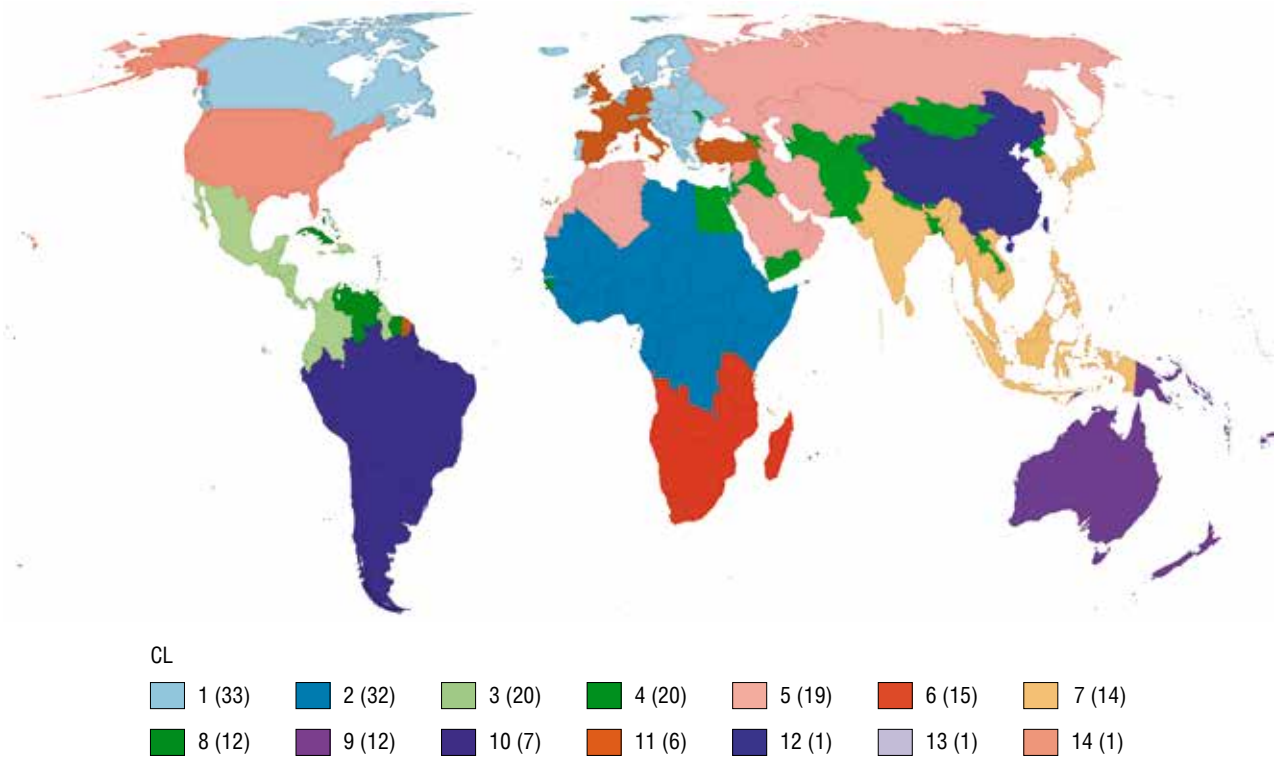
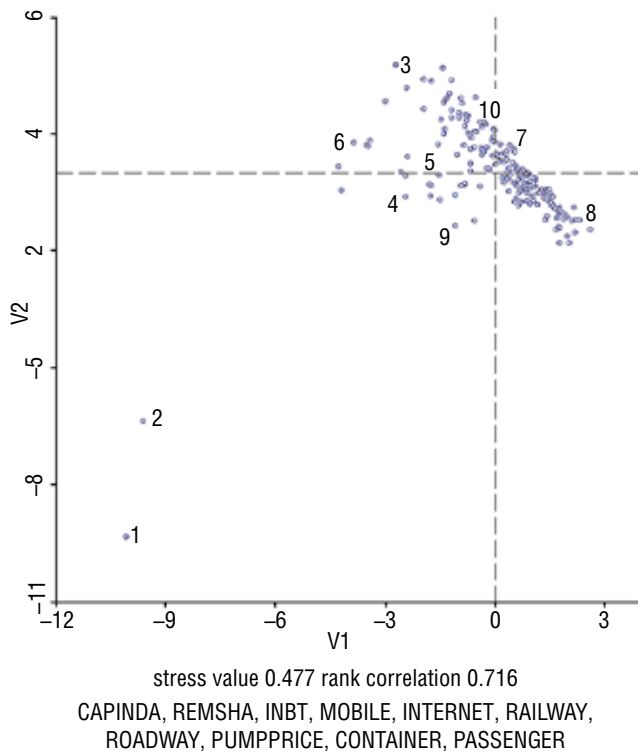


Fig. 10.11.4. Statistical clusters cartogram for the "Mobility" section indicators adjusted for geographic proximity



1	China
2	United States
3	Switzerland
4	Turkey
5	Russia
6	Germany
7	Moldova
8	Haiti
9	India
10	Uruguay

Fig. 10.11.5. Multidimensional scaling chart for the “Mobility” section indicators

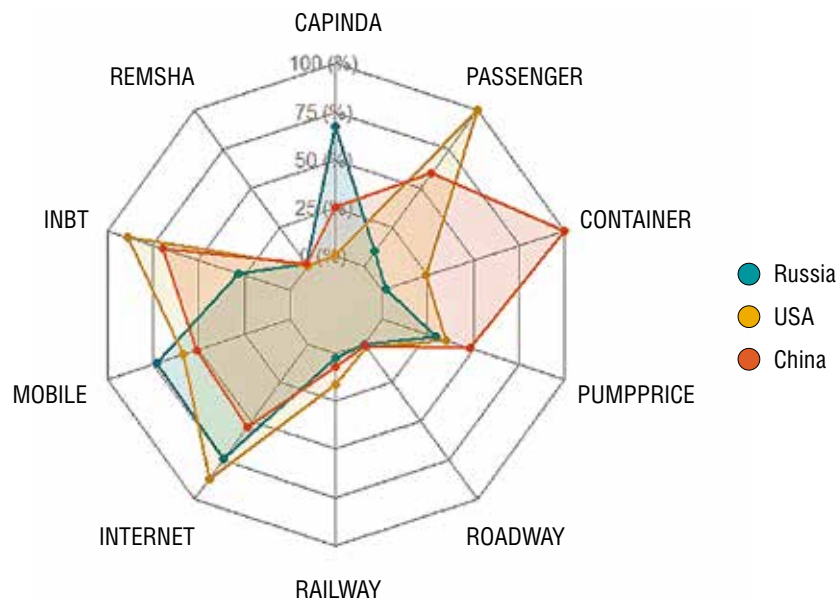


Fig. 10.11.6. Radar chart for the “Mobility” section indicators

10.12. Spatial factor for the “Mobility” section indicators

A comprehensive analysis of the indicators in this section allows us to identify certain spatial effects in their distribution. Looking at the spatial autocorrelation results, we see that Moran's I produces a sufficiently high result for both neighbourhood matrices (0.555 for the geometric neighbourhood matrix and 0.447 for the geopolitical neighbourhood matrix) in just one case — the number of internet users. This suggests that countries with high internet penetration are more likely to be surrounded by similar countries, and vice versa. The remaining indicators demonstrated a weak ($r > 0.01 \leq 0.29$) or moderate positive spatial autocorrelation. In some cases, the calculations were invalid because the significance level (p-value) exceeded 0.05. Overall, the hypothesis that the geopolitical neighbourhood has greater significance than the geometric neighbourhood matrix is not confirmed for the “Culture” section: in all cases, Moran's I turned out to be lower for geopolitics than for geometry, in some cases by two times.

A two-factor analysis of the results of the spatial effect index shows that all sections are represented fairly equally, with the exception of the “Finance” section, which was represented by a single indicator in just one case. At the same time, the highest score on the spatial effect index was observed for the “Railway network” indicator (SEI = 6.49, with seven more pairs achieving an SEI of greater than 1). However, this was with an extremely low coefficient of determination, meaning that the correlation is weak. As for “Inbound tourism,” three indicators had SEI > 1 and a low coefficient of determination.

Our analysis of the spatial autocorrelation cartograms revealed that the most noticeable neighbourhood effect is observed in Europe (for the geometric matrix) or the EU–NATO bloc (for the geopolitical matrix), although in the latter case, Canada and/or the United States are often outliers. This trend is confirmed by the likelihood-ratio test for geometry and the indicator in question. What we thus see is a manifestation of both the geographic and essential proximity of Europe, which is only strengthened through integration processes.

Another notable trend can be observed in Africa. Here, the densest “nodes” of connections are in Central and East Africa, which leads to the formation of low-value clusters in this part of the continent for various indicators of mobility for both the geometric neighbourhood matrix and the geopolitical neighbourhood matrix. The latter indicates that African countries that belong to different geopolitical blocs are nevertheless similar to each other in many other respects. At the same time, South Africa sometimes acts as a notable exception to the general trends observed in Africa; in the case of the “Mobility” section, it differs both from its geographic neighbours and from its partners in the SACU–SADC bloc.

In general, the influence of spatial factors, including the neighbourhood effect, is only observed in relation to some indicators in the “Mobility” section.

As an assessment of how spatial factors present themselves, we can say that there is a kind of fragmentation of global space into regions with multidirectional trends. However, in those parts of the world where high levels of correlation are observed for certain indicators of mobility (number of mobile subscribers, total road length, or traffic volumes, for example), it is more likely that individual countries will “fit in” with the general trend. The spatial factor for this section can thus be observed not so much at a global level, but rather as an influence on regional manifestations.

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11 *Ecology*

Agricultural land

Forest areas

Conservation areas

Depletion of natural resources

Fresh water

Renewable energy

Availability of electricity

CO₂ emissions

Particulate air pollution

Light pollution

THE Ecology is one of the most important factors affecting the quality of human development. Our existence in an ecological environment is measured by varying degrees of wellbeing, which has a significant impact on the quality of life in general. This is why, along with other indicators of human potential, we had to include a section on the environment in this Atlas of Human Development and pay attention to various metrics that, in our opinion, determine the human ecosystem to one degree or another, demonstrating differences between countries.

If we use the classical definition of ecology as the science of habitat, or environment, given by Ernst Haeckel back in the 19th century (a definition with which we agree), then it would be wise to consider a number of parameters that characterize the environment in which people live in the broadest sense of the word. Of course, ecology, both as a science and a concept, is too far-reaching for us to cover all of its aspects in this study. Accordingly, we did not set ourselves such a task. Instead, we decided to focus on indicators that are related to a greater degree to such areas as the ecology of the biosphere and industrial ecology, the so-called resource base or resource availability (these make up one part of the parameters) that affects human development potential, as well as the human impact on the environment (anthropogenic parameters).

Bearing in mind these selection criteria (mentioned in the preface to the Atlas), we settled on the following indicators:

1. Agricultural land (calculated as a proportion of the total land area of the state). In this case, agricultural land refers to the total area of a given territory that is occupied by arable land, permanent crops and permanent pastures. This indicator is, of course, important for understanding numerous characteristics of human development. As the global statistics provided by the Food and Agriculture Organization of the United Nations (FAO) show, it is difficult to reduce this indicator to a single denominator, as comparing data for different climatic zones presents numerous difficulties. That said, we nevertheless believe it is a sufficiently universal indicator and an important one for characterizing human habitat. In our classification, agricultural land is referred to as a “resource” indicator, since it covers more than one-third of the entire land area of the world.

2. Forest areas (calculated as a proportion of the total land area of the state). This is another important “resource” indicator: forests cover approximately 31% of the global land area, at just over 4 billion hectares. The FAO defines forest area as areas that grow naturally or artificially planted trees at least five metres in height, not counting crop trees and trees located in city parks and squares. More than one-third is primary forest (forests of native species, where there are no visible indications

of human activities and the ecological processes are not significantly disturbed). However, the world's forest resources are being depleted for numerous reasons, primarily due to anthropogenic impacts. The loss of forests leads to the impoverishment of biodiversity. It is thus of vital importance to ensure the sustainability of forest areas in order to maintain the quality of the habitat.

3. Conservation areas (calculated as a proportion of the total land area of the state). This is another extremely important factor for assessing the quality of human habitat, and it includes both land and aquatic conservation areas. The former refers to territories with an area of at least 1000 hectares that are partially or fully protected by national legislation (reserves, national parks, natural monuments, protected landscapes, etc.), while the latter includes tidal areas, as well as all water bodies of states and related flora and fauna protected by state legislation. Our source for this indicator was the World Database on Protected Areas compiled by the United National Environment World Conservation Monitoring Centre (UNEP-WCMC). Conservation areas are an important part — one could even say they form the foundation — of almost all national and international strategies for the conservation of the environment, since their protected status allows for the conservation of biological sustainability and even the enhancement of biodiversity, which is so important for the conservation of habitats on a global scale.

4. Depletion of natural resources. This indicator represents an aggregate of net forest depletion and mineral depletion, and is an important component in the calculation of adjusted net national income (World Bank data) — gross national income (GNI) minus the consumption of fixed capital (giving us net national income) and the depletion of natural resources (which is similar to the depreciation of fixed assets). Net deforestation is the normalized resource rent multiplied by the excess of roundwood over natural growth (this refers to the value of the timber only, and not in terms of deforestation). Energy depletion refers to the ratio of the value of a stock of energy resources (coal, crude oil and natural gas) to the remaining stock of those resources. Mineral depletion is the ratio of the value of a mineral source (tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite and phosphate) to the remaining life of the resource. The offset for the depletion of natural resources reflects the decline in the value of assets associated with the extraction of natural resources, which is similar to the depreciation of fixed assets.

5. Fresh water (million cubic metres). Another extremely important indicator (provided by the United Nations Statistics Division, UNSD) that is essential for understanding the quality of the human environment. Water availability, in particular access to fresh water, has become perhaps the most important and in-demand resource across the globe in recent times. And this situation will likely continue in the future.

6. Renewable energy. This indicator is vital for understanding how prepared humanity is for new energy-saving technologies in the field of electricity consumption. It is measured as the share of electricity generated by renewable power plants as part of the total amount of energy generated by all types of power plants.

7. Availability of electricity. Related to the previous indicator, this refers to the availability of electricity per capita. The supply of electricity itself is calculated as the total amount of energy produced, including imported electricity, but not including exported energy.

8. CO₂ emissions. A significant parameter that reflects the quality of the human environment and illustrates the ever-increasing anthropogenic pressure on the planet, measured in carbon dioxide emissions (in metric tons per capita). Carbon dioxide is the most commonly produced gas as a result of human economic activity. As such, it is the main anthropogenic gas that affects the radiation balance of the planet and that causes the so-called greenhouse effect. It is a reference gas against which the global warming potential of other greenhouse gases is measured. CO₂ emissions have affected the climate, the rate of change of which is directly proportional to the increasing emissions of the gas. Carbon dioxide is also responsible for ocean acidification. Of course, for a more complete picture of how a country is affecting climate change, we need to look at emissions of other gases such as methane and nitric oxide too. In this study, we will focus on gas, the most significant contributor to the anthropogenic load, and one which affects the environment more than anything else.

9. Particulate air pollution (particulate matter less than 2.5 microns). Another indicator which, alongside carbon dioxide emissions, describes the consequences of various kinds of human activity. Particulate air pollution (particulate matter less than 2.5 microns), otherwise referred to as PM2.5 according to the international classification, is defined as the average annual level of exposure of the population to PM2.5 emissions per cubic metre of air. These particles have an extremely negative effect on the respiratory tract, as well as on other organs, thus causing great damage to human health. The rationale for using this indicator is that it is a direct consequence of anthropogenic and (to a lesser extent) natural load and reflects the degree of atmospheric pollution. And while it has its limitations (direct PM2.5 monitoring is not carried out in all countries, for example, or according to the same protocols), the data can be considered a general indicator of air quality, which fits perfectly into the concept of our project.

10. Light pollution. A relatively recent phenomenon that is growing at a rapid pace, initially with the development of industry, but even more with the development of urbanization, which has spread to all continents. The breakneck speed at which technology is developing in the 21st century means that this is a phenomenon of a planetary scale. From the point of view of ecology, it describes the increase in the anthropogenic load and the impact not only on humans and the entire ecosystem, but also on astronomical phenomena. Excessive and often pointless lighting creates a wide range of problems, from additional economic costs to harm to psychological and physical health. Light pollution (or light smog) is a modern challenge to the entire ecosystem. Light pollution is calculated as the amount of “luminosity” per 1000 people (it is a complicated integrated indicator obtained monthly from satellites and extrapolated to an annual average).

It would, of course, be useful to consider such environmental factors per person as abiotic (inanimate) and biotic (animate). Further, it would be instructive to pay attention to such indicators as recycling and waste disposal, the capture of harmful substances, the number and scale of natural and manmade disasters, the amount of money spent on environmental protection, the monitoring of endangered species of flora and fauna, the incidence of environmental crimes, and so on — in other words, all the anthropogenic factors that describe and quantify the inevitable and growing pressure on the environment.

Unfortunately, however, complete and reliable databases do not exist for many of these parameters, and they thus fall short in terms of meeting our research objectives. Let us stress once again that we are not aiming for a comprehensive overview of the ecological impact on human development (and human development on the environment) with the indicators we have selected. That said, we nevertheless hope that these indicators adequately reflect various aspects of such a broad concept as ecology.

11.1. Agricultural land

Agricultural land can be defined as the total area of a given territory that is occupied by arable land, permanent crops and permanent pastures. Scores for this indicator are calculated as the weighted average of the share of agricultural land in the total area of the state. This is an important indicator for describing the role of agriculture in the country's economy and the impact of agricultural development on the environment.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.228	0.000	0.095	0001
Geary's C	0.755	0.000	0.901	0.001

The percentile cartogram (Fig. 11.1.1) shows a wide range of results for this indicator, with high values being concentrated in Central, South Asia, Europe, Mexico, the USA, and Southern and East Africa. Particularly noteworthy are such Asian countries as Kazakhstan, which specializes in the production of wheat and other grains, and Mongolia, whose territory is mostly arable pastures. The United Kingdom and Denmark also stand out for their relatively well-developed agriculture. Conversely, the indicator values for such countries as Norway, Sweden and Finland are extremely low. This is because a significant part of the territories of these countries is located in zones that are unsuitable for agriculture, as well as because they primarily engage in intensive farming. The countries of Oceania, North and Central Africa, as well as many South American states (Brazil, Chile, Bolivia and Ecuador), also scored low on this indicator, which may be explained by a number of factors, including landscape heterogeneity, climatic conditions that are not favourable for agricultural activities, and an economic structure that is geared towards other areas. Another country with low values for this indicator is Canada, where the cold climate means that agriculture is concentrated in a relatively small area. A wide range of values is observed in the Middle East for this indicator, with Oman, Iraq and Iran scoring low on this metric and Qatar, Kuwait, the United Arab Emirates and neighbouring Egypt, Syria and Yemen scoring relatively high. Meanwhile, Saudi Arabia is among the leaders thanks to the significant investments the country makes in its agricultural sector. While it is true that oil production and processing are the main sources of income for Saudi Arabia, a significant portion of its territory is given over for growing date palms and raising livestock.

The geometric neighbourhood matrix yields a slightly greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

Global place	Country	Indicator (%)
1	Uruguay	82.6
2	Saudi Arabia	80.8
3	Kazakhstan	80.4
Median (96)	Portugal	39.5
Mean (100)	(Mauritania)	38.8361 (38.5)
189	Singapore	0.9
190	Suriname	0.6
191	South Sudan	0

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.1.3) shows a distinct cluster of countries in mainland Europe with a low proportion of agricultural land. These countries include Norway, Sweden, Finland and Denmark. Denmark is something of an outlier among the countries in this low-performing cluster, however, as it scores higher in the indicator. This is somewhat unexpected given the level of development of agriculture in the country, which is mainly based on pastoralism.

Israel, Egypt and Sudan form a cluster of low values. The Central African Republic adjoins it from the south. At the same time, Sudan gets into this cluster due to the lack of statistics on this indicator when the data was collected.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.1.4) reveals a cluster of CIS countries in which Russia and Tajikistan have low scores, despite the high scores of their neighbours. This may be due to the relatively small share of arable land in Russia, which is mostly occupied by forests, as well as to the generally unfavourable economic situation in Tajikistan, where cotton and grain production, as well as animal husbandry, are sufficiently developed, even though it lags behind its neighbours in these areas. Africa shows a cluster of high values in the southern countries united in the Southern African Customs Union and parts of the Southern African Development Community. On the other hand, it also points to the fact that, environmentally speaking, parts of these territories remain untouched, and thus undamaged, by man.

It is difficult to say with any degree of certainty whether or not the share of agricultural land is environmentally positive, as it only reflects one aspect of a country's development in terms of human interaction with the environment and describes a small part of the human environment. In order to form a more accurate conclusion, we would need to look at the share of agriculture in the country's GDP and pay attention to the needs of the population, as well as the agricultural potential of its territories, the quality of the soil, and the natural and climatic conditions.

The likelihood-ratio test for geometry and "Agricultural land" (Fig. 11.1.2) points to the potential for the balanced development of agricultural land in Southeast Africa. Additionally, we can see the necessary conditions for clustering in mainland Europe and the Asia-Pacific, which may be due to the similar climates and topographies of the countries that make up these groups of neighbours.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Access to electricity	0.026	0.025	-0.167	1.073
2	Infant mortality	0.026	0.027	0.133	0.68
3	Internet users	0.039	0.007	-0.128	0.42
4	HIV incidence	0.038	0.032	0.126	0.418
5	CO ₂ emissions	0.061	0.001	-0.159	0.414
6	Life expectancy	0.042	0.05	-0.129	0.396
7	Female population	0.072	0	0.164	0.374
8	Military spending	0.028	0.038	-0.102	0.372
9	GDP (PPP) per capita	0.049	0.002	-0.13	0.345
10	Mobile subscribers	0.027	0.032	-0,083	0.255

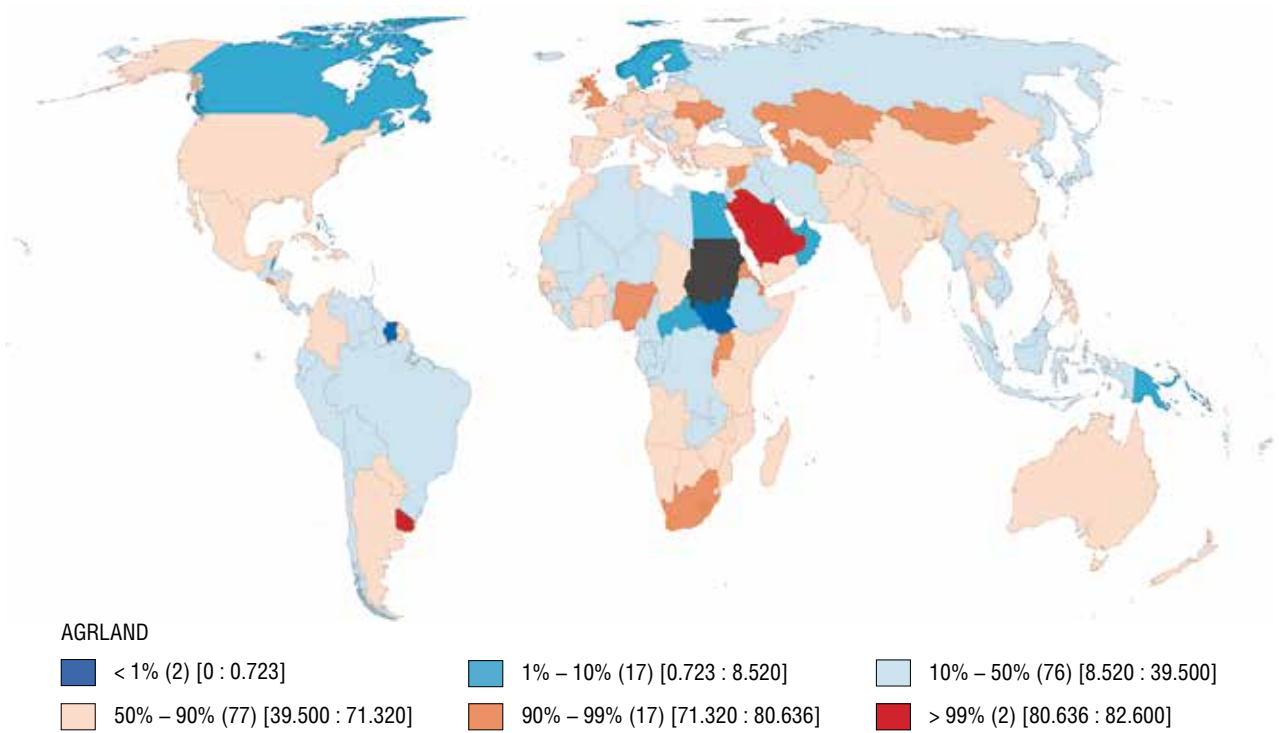


Fig. 11.1.1. Percentile cartogram for the “Agricultural land” indicator

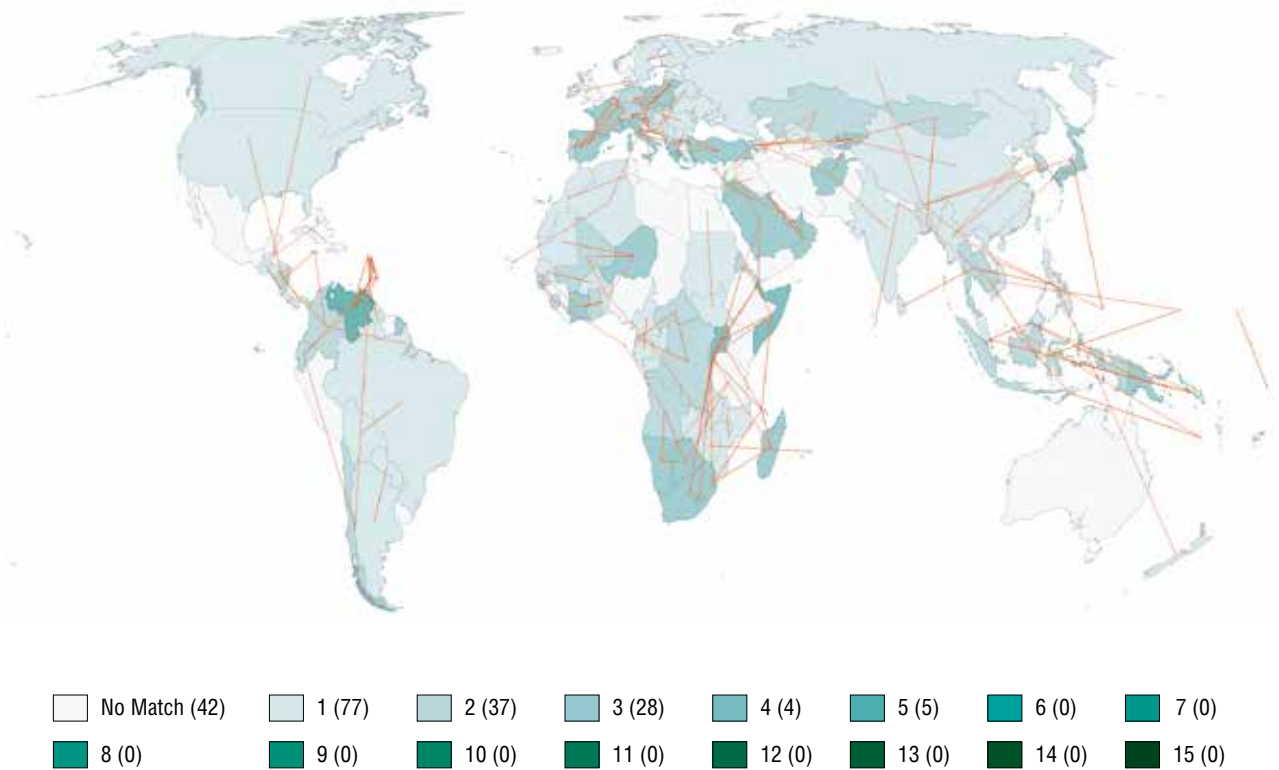


Fig. 11.1.2. Likelihood-ratio test for the “Agricultural land” indicator

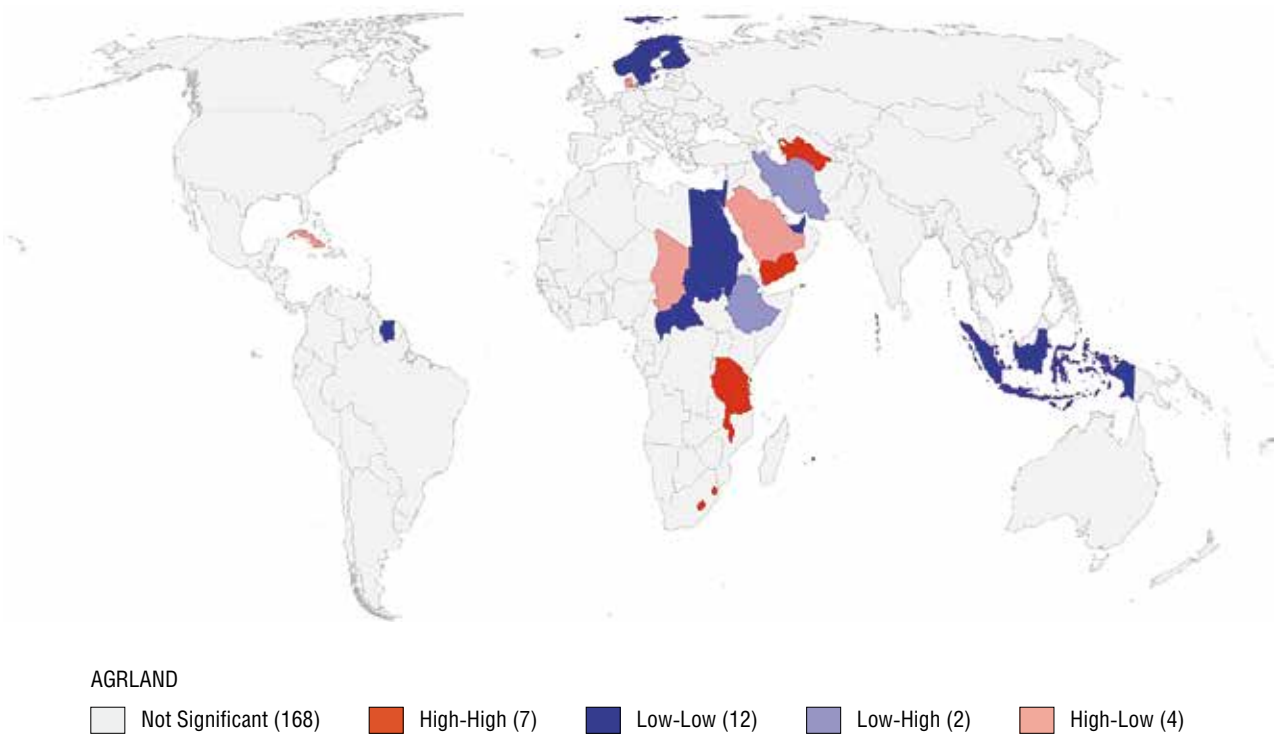


Fig. 11.1.3. “Agricultural land” spatial autocorrelation cartogram for the geometric neighbourhood matrix

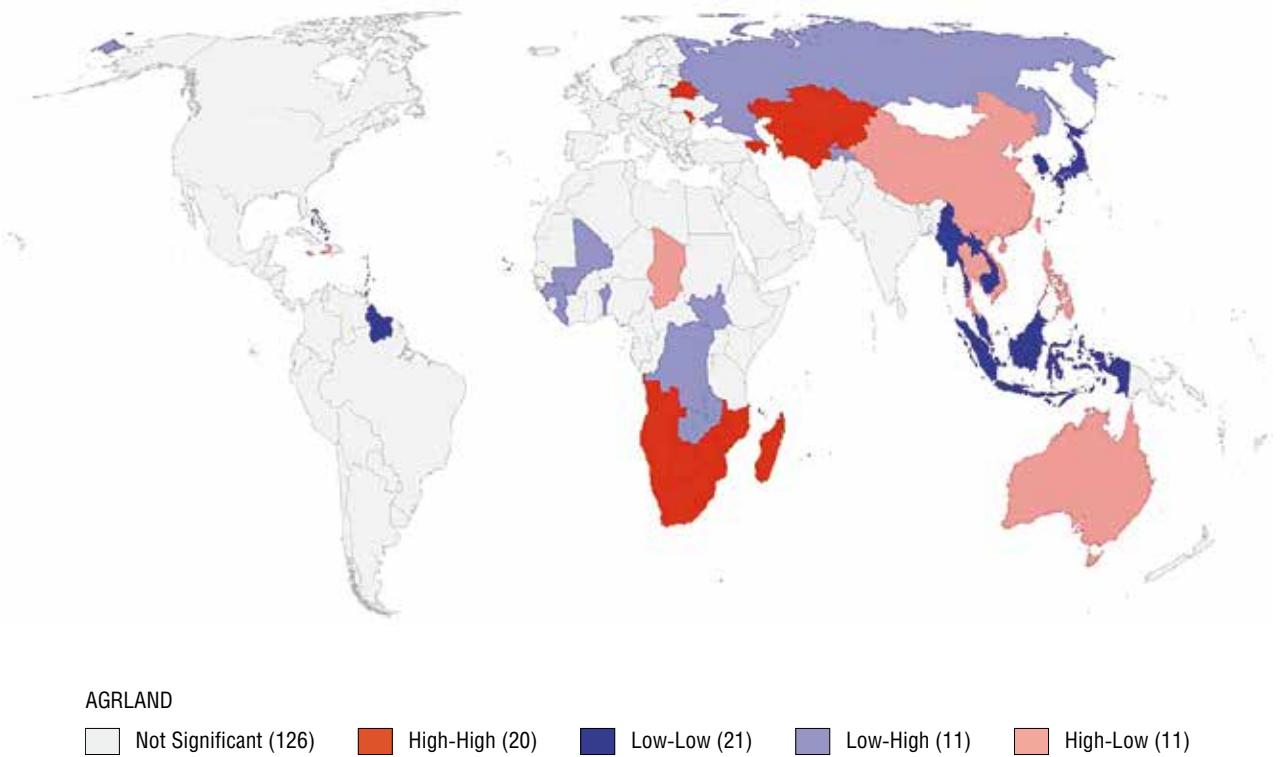


Fig. 11.1.4. “Agricultural land” spatial autocorrelation cartogram for the geopolitical metric neighbourhood matrix

11.2. Forest areas

Forest areas refers to the share of forest areas in the country, and it gives us an idea of the potential of the state's forest resources, as well as its natural wealth and the diversity of its flora and fauna.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.407	0.000	0.278	0.000
Geary's C	0.581	0.000	0.718	0.000

The percentile cartogram (Fig. 11.2.1) indicates that the largest share of forest areas is concentrated in North America, the countries of the Amazon basin, Russia, Northern Europe, the Baltic states, much of Central and Western Europe, Central Africa, South East Asia, and Oceania. Most of the countries that scored high on this indicator are located in the natural zones of forest-tundra and taiga in the north, as well as in the broad-leaved forests and tropics in the south. The countries with the smallest share of forest areas are located in the arid and semi-arid climates of Central Asia, the Middle East, North and Southern Africa and Australia.

The countries with the highest percentage of forest areas are predominantly small states located in the hot-humid climate zone, as well as island states. Countries located in the most arid regions score lowest on this indicator.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.2.3) gives us three clusters, two low-value and one high-value. The biggest cluster is in the Middle East and North Africa and is made up of countries with the smallest share of forests due to their position in the desert climatic zone, where annual temperatures are typically high and humidity is low. High-value clusters are located in

Global place	Country	Indicator (%)
1	Suriname	98.3
2	Micronesia	91.9
3	Gabon	90
Median (94–96)	Guatemala, Germany, Côte d'Ivoire	32.7
Mean (97)	(Thailand)	32.0126 (32.2)
183–184	Djibouti, Mauritania	0.2
185–186	Egypt, Libya	0.1
187–191	Qatar, Nauru, Oman, San Marino, South Sudan	0

the Amazon basin and on the islands between Asia and Australia. These clusters unite countries that are located in the tropics and equatorial forests, where the climate is the most humid.

The cartogram for the geopolitical neighbourhood matrix (Fig. 11.2.4) shows several spatial clusters. The first is a low-value cluster that is made up of all the Arab League countries. This is fully in line with the geographical position of the countries in this political association and predetermines the structure of their economies, which are based on the production of oil and gas. The second is a cluster that includes several ASEAN countries. China, Thailand and the Philippines are outliers in this cluster, as the share of forest areas in these countries is below the expected level compared to other ASEAN countries. The third cluster is made up of countries from the Economic Community of Central African States, excluding Chad, which scored low on this indicator, somewhat surprisingly given that the south of the country is mainly wetlands and tropical forests — but it turns out that forest land makes up no more than 4% of the country's total area.

The likelihood-ratio test for geometry and forest areas (Fig. 11.2.2) indicates that the prerequisites for regional clustering that we mentioned earlier are generally present. The homogeneity of indicator values for North Africa, Central Asia and the Middle East, as well as for the Amazon basin in South America and the tropics of Southeast Asia, can be explained by the fact that the countries in these regions have similar climatic conditions that are conducive to forest growth and constitute the “lungs” of the planet.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Women's unemployment	0.025	0.036	-0.177	1.253
2	Population growth	0.025	0.029	-0.17	1.156
3	Female population	0.037	0.009	0.186	0.935
4	Suicide rate	0.027	0.036	0.146	0.789
5	Female employment	0.077	0	0.219	0.623
6	Military spending	0.113	0	-0.257	0.585
7	Passport power	0.039	0.006	0.149	0.569
8	Institutional foundations of democracy	0.07	0	0.197	0.554
9	Refugees	0.037	0.015	-0.142	0.545
10	Hospital beds	0.057	0.015	0.137	0.329

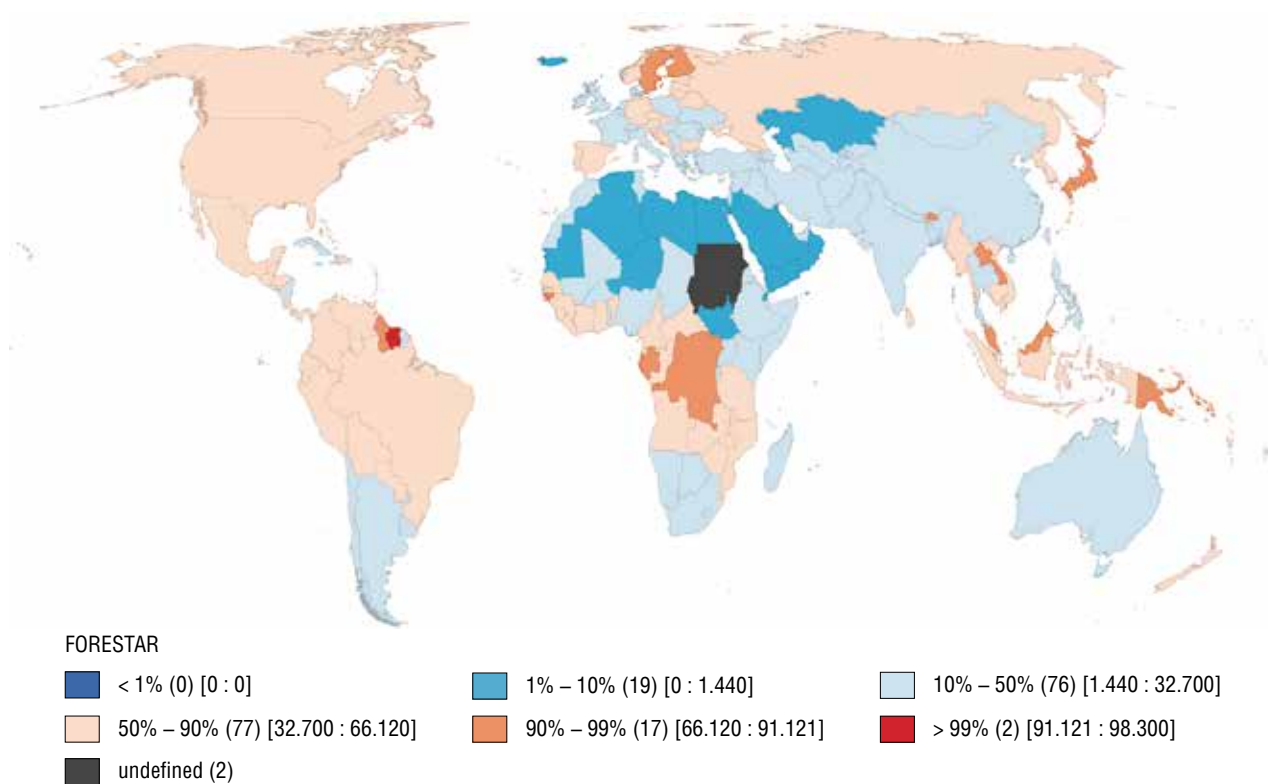


Fig. 11.2.1. Percentile cartogram for the “Forest areas” indicator

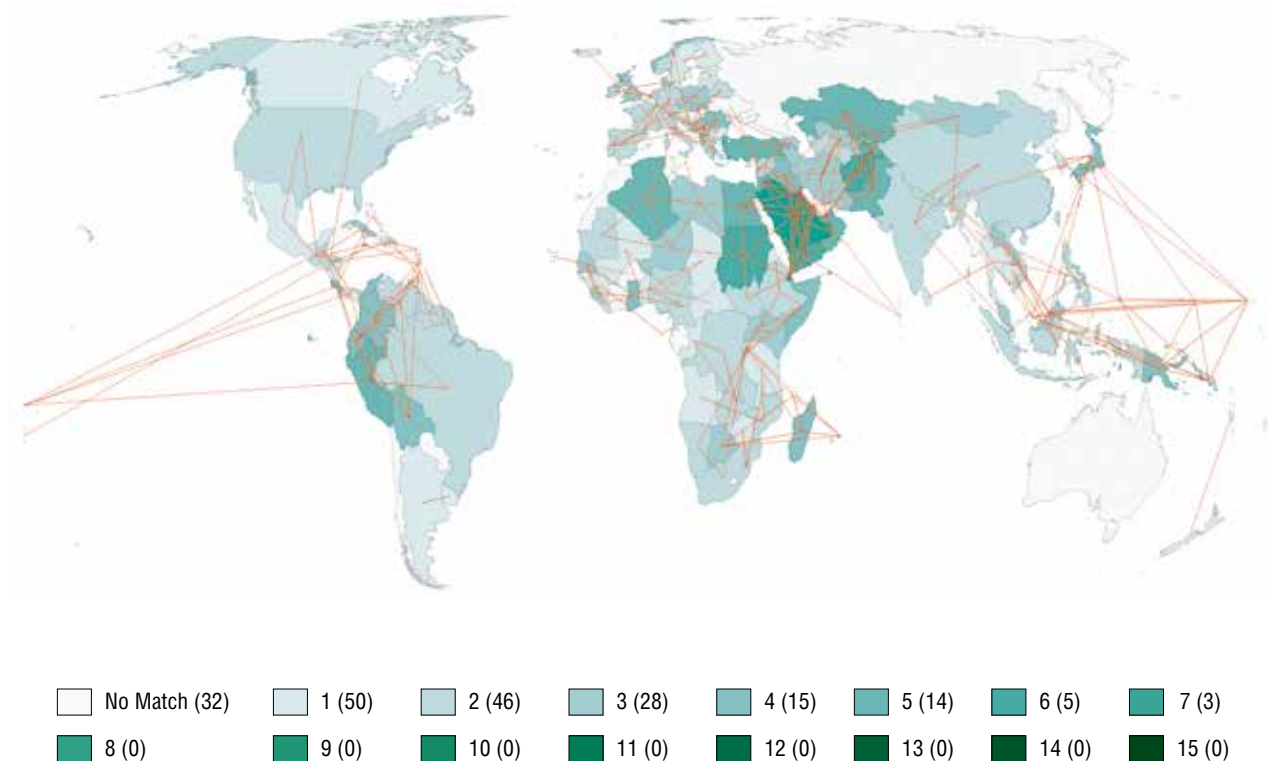


Fig. 11.2.2. Likelihood-ratio test for the “Forest areas” indicator

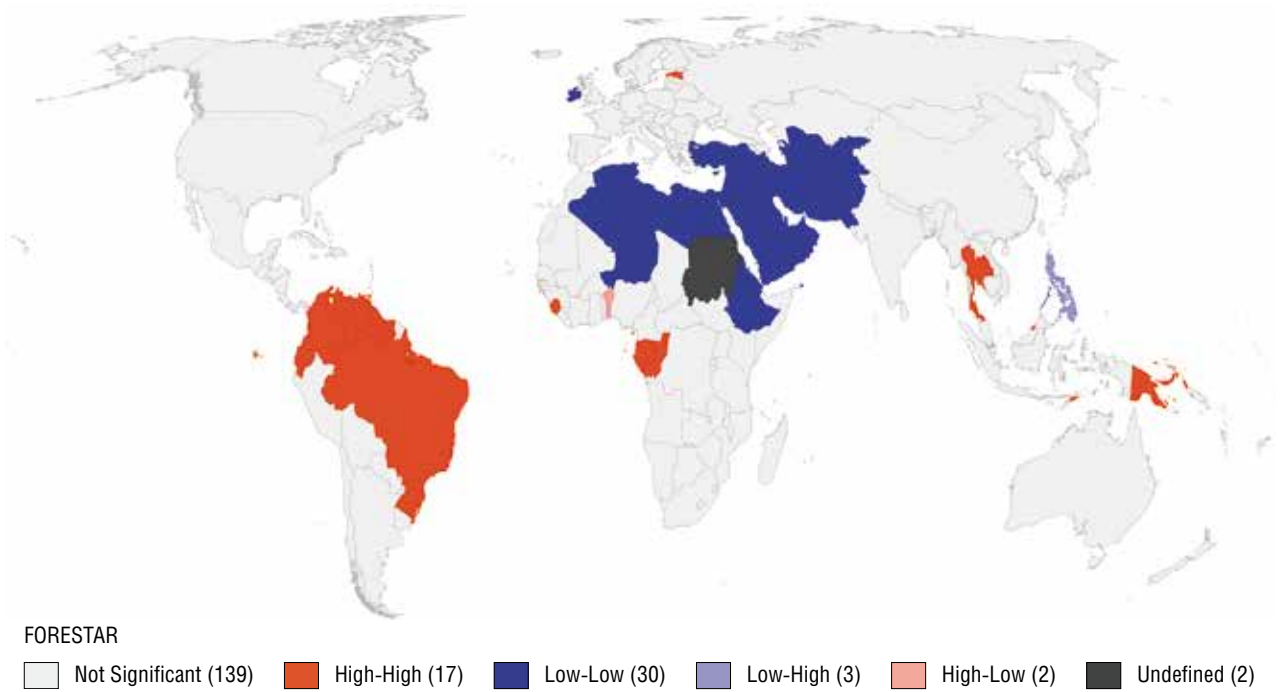


Fig. 11.2.3. “Forest areas” spatial autocorrelation cartogram for the geometric neighbourhood matrix

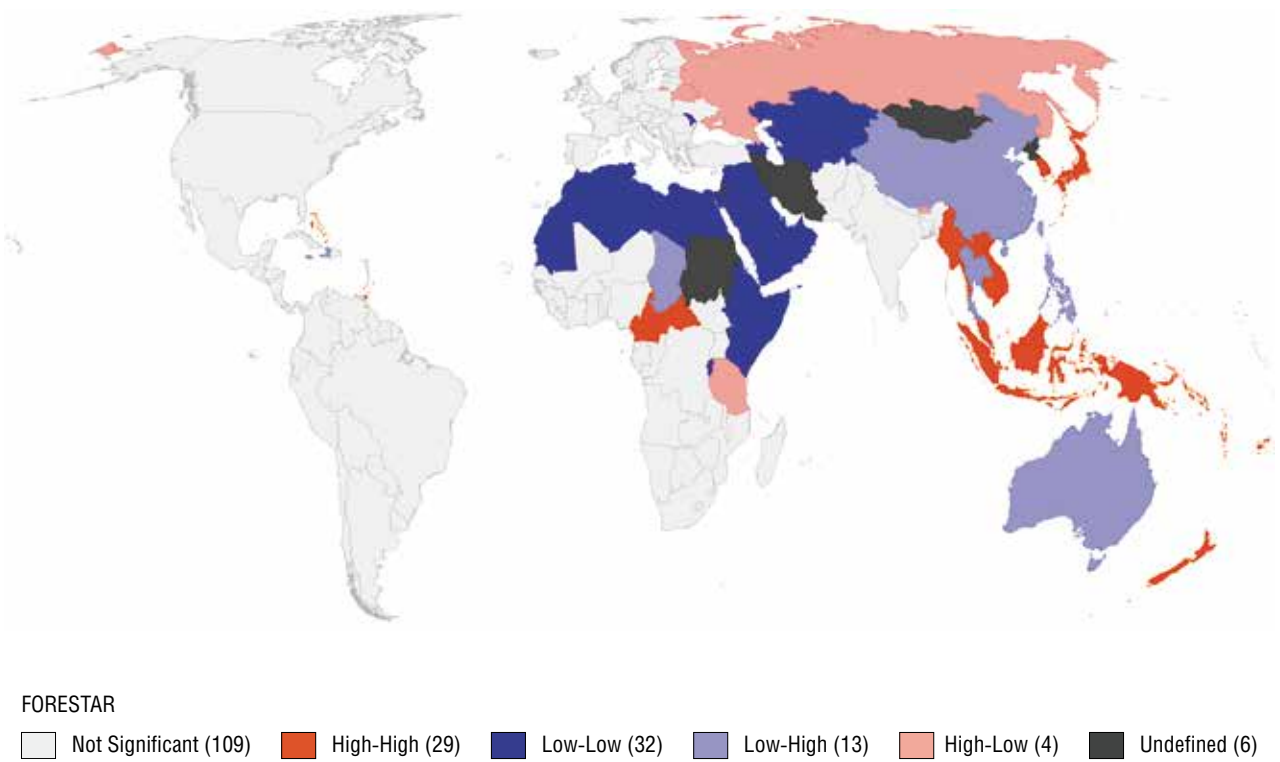


Fig. 11.2.4. “Forest areas” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.3. Conservation areas

Conservation areas refers to the size of protected areas proportionate to the total area of the country. The share of protected areas reflects the potential for conservation and enhancement of biodiversity. Conservation areas are an important part of many national and international environmental strategies.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.138	0.001	0.091	0.001
Geary's C	0.828	0.009	0.905	0.001

The countries with the highest percentage of protected areas are located in the Amazon (Brazil, Bolivia and Venezuela), Europe (France, the United Kingdom, Germany, Poland, Slovakia and Slovenia), Australia, and a number of sub-Saharan African countries. The desire to preserve the unique diversity of flora and fauna in these regions of the world is quite understandable, because numerous animal and plant species common to them are not found anywhere else on the planet. The percentile cartogram (Fig. 11.3.1) shows that the lowest scores for this indicator are mostly found in the CIS countries, including Russia, as well as in the Persian Gulf, South Asia, North Africa, several island states, Somalia, Afghanistan, Turkey.

Notably, the countries with the highest scores on this indicator have small territories, around eight times smaller than the largest country on average, which points to the relatively low proportion of protected areas worldwide. Many island states do not have any protected areas at all. The same is true for countries located in politically unstable regions. This can also be explained by the need for these countries — for example, the Maldives, Seychelles and Comoros — to attract large numbers of tourists to areas where there is not a significant threat to the environment.

The geometric neighbourhood matrix yields a slightly greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.3.3) gives us one fairly distinct high-value cluster, which is located in Europe and primarily includes the countries of Central,

Global place	Country	Indicator (%)
1	Monaco	99,5
2	Palau	82,9
3	Slovenia	55,1
Mean (76)	(Thailand)	12,2927 (12,5)
Median (97–98)	Bahamas, Israel	8,6
176–180	Grenada, Samoa, São Tomé and Príncipe, Solomon Islands, Turkey	0,2
181–185	Afghanistan, Vanuatu, Comoro Islands, Maldives, Seychelles	0,1
186–193	Barbados, Cape Verde, Mauritius, Micronesia, Nauru, San Marino, Somalia, Tuvalu	0

Western and Southern Europe. With the exception of the Czech Republic, Eastern European countries are not represented in this cluster at all. Switzerland also did not make it into this cluster, scoring lower than expected on this indicator, which can most likely be put down to the fact that the country is densely populated. Another high-value grouping can be found in Southern Africa, specifically in those regions where national parks are common, although its irregular shape means that it does not form a cluster proper.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 11.3.4) gives us two spatial clusters. The first is a Euro-Atlantic cluster that unites the most developed countries with a predominantly post-industrial economy. However, the wide variety of natural and economic indicators and opportunities of the countries in this group means that there are a number of outliers — countries that should have scored highly but did not. These include, on the one hand, countries that are located in more severe climatic zones, for example, Canada, Iceland, Ireland and Norway. On the other hand, these are countries where agriculture occupies a significant share in their national economies, meaning that the land is actively used for economic needs. Examples here include Bosnia and Herzegovina, Montenegro, Serbia, North Macedonia and Turkey. The second is made up of Arab League countries, most of which scored low on the indicator. Exceptions here are Morocco, Sudan and the United Arab Emirates, which have a higher proportion of protected areas in their respective territories.

Notably, the countries of the geopolitical blocks ANZUS, ASEAN, SADC do not make up clusters of spatial autocorrelation for geopolitical neighborhood matrix, and are also not included in the existing clusters (Euro-Atlantic or Arab). This indicates the low spatial dependence of the countries of these geopolitical blocks. The likelihood-ratio test for geometry and the “Conservation areas” parameter (Fig. 11.3.2) allows us to identify a prerequisite for clustering the countries of Oceania, which points to a uniformity in the development of environmental activities in these countries. Uniformity is also observed in the countries of the Amazon basin, and in Central and Southern Europe. It is noteworthy that neither the United States, nor China have significant potential neighbors, which tells us that they each have different approaches to protecting nature than their neighbors, a likely consequence of their large size and the exceptional level of industrial development in these countries.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Women in politics	0.046	0.003	0.204	0.905
2	Healthcare spending	0.05	0.002	0.207	0.857
3	Number of doctors	0.053	0.001	0.205	0.793
4	Renewable energy	0.026	0.026	0.139	0.743
5	Passport power	0.054	0.001	0.171	0.542
6	Institutional foundations of democracy	0.032	0.012	0.128	0.512
7	Publication activity	0.073	0	0.185	0.469
8	Export	0.033	0.014	0.119	0.429
9	Suicide rate	0.051	0.004	0.147	0.424
10	Religious diversity	0.021	0.045	0.093	0.412

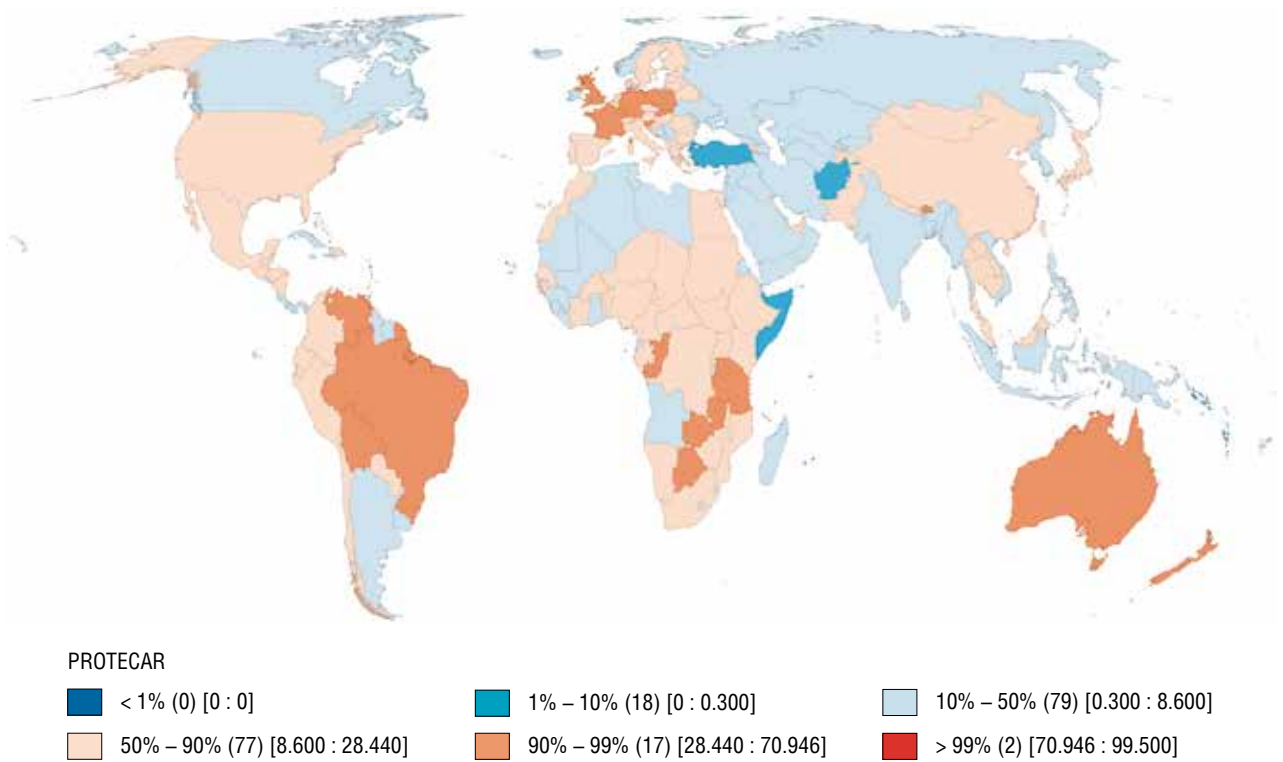


Fig. 11.3.1. Percentile cartogram for the “Conservation areas” indicator

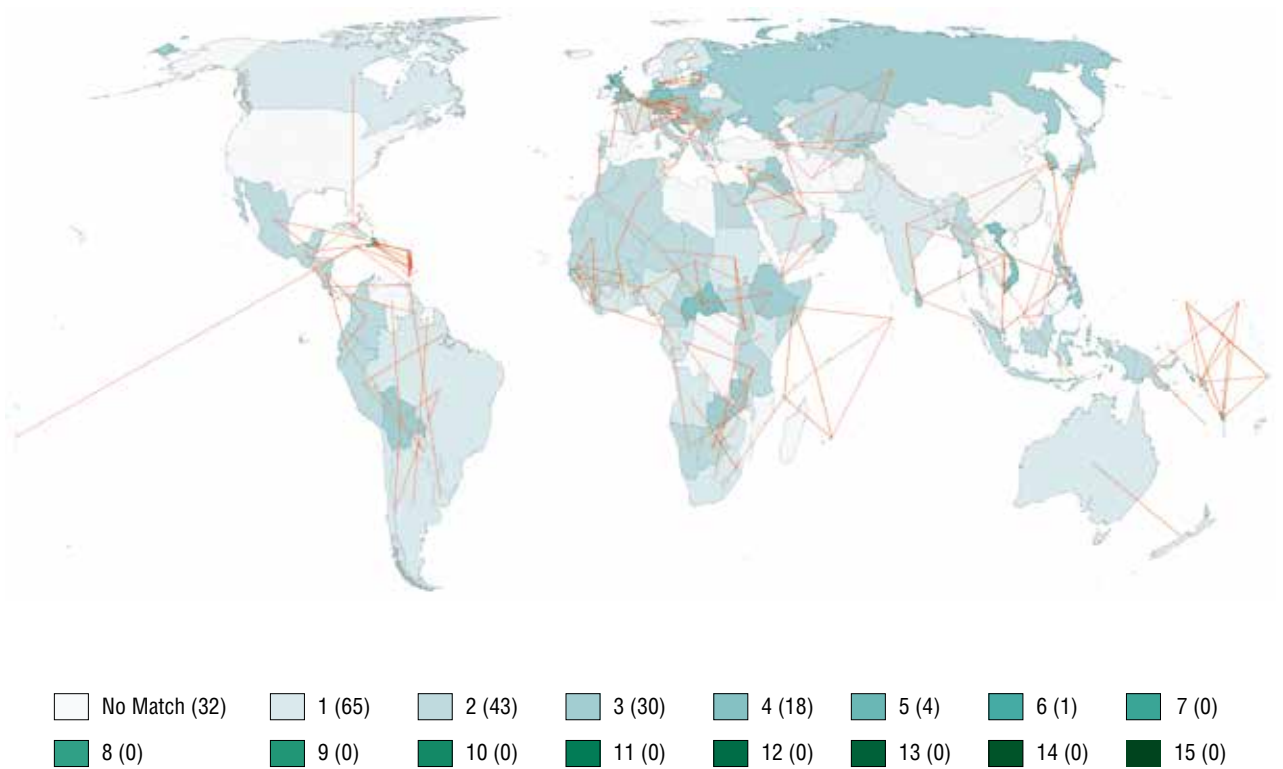


Fig. 11.3.2. Likelihood-ratio test for the “Conservation areas” indicator

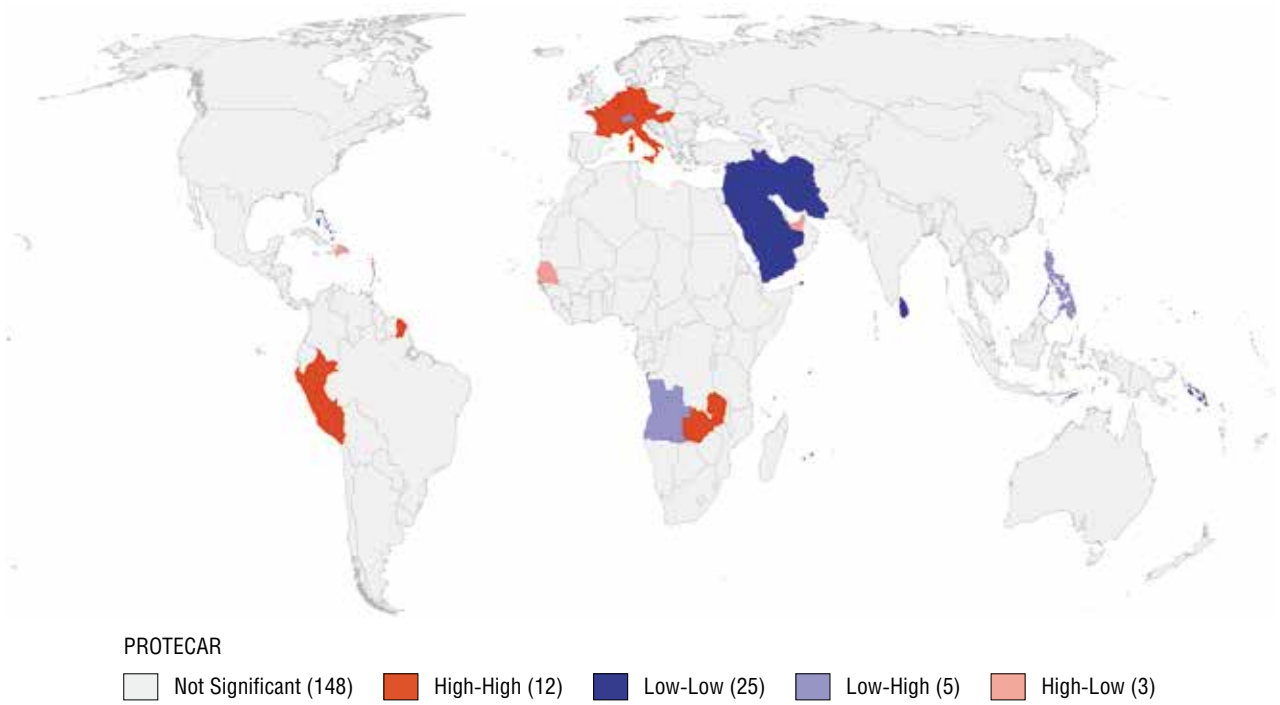


Fig. 11.3.3. “Conservation areas” spatial autocorrelation cartogram for the geometric neighbourhood matrix

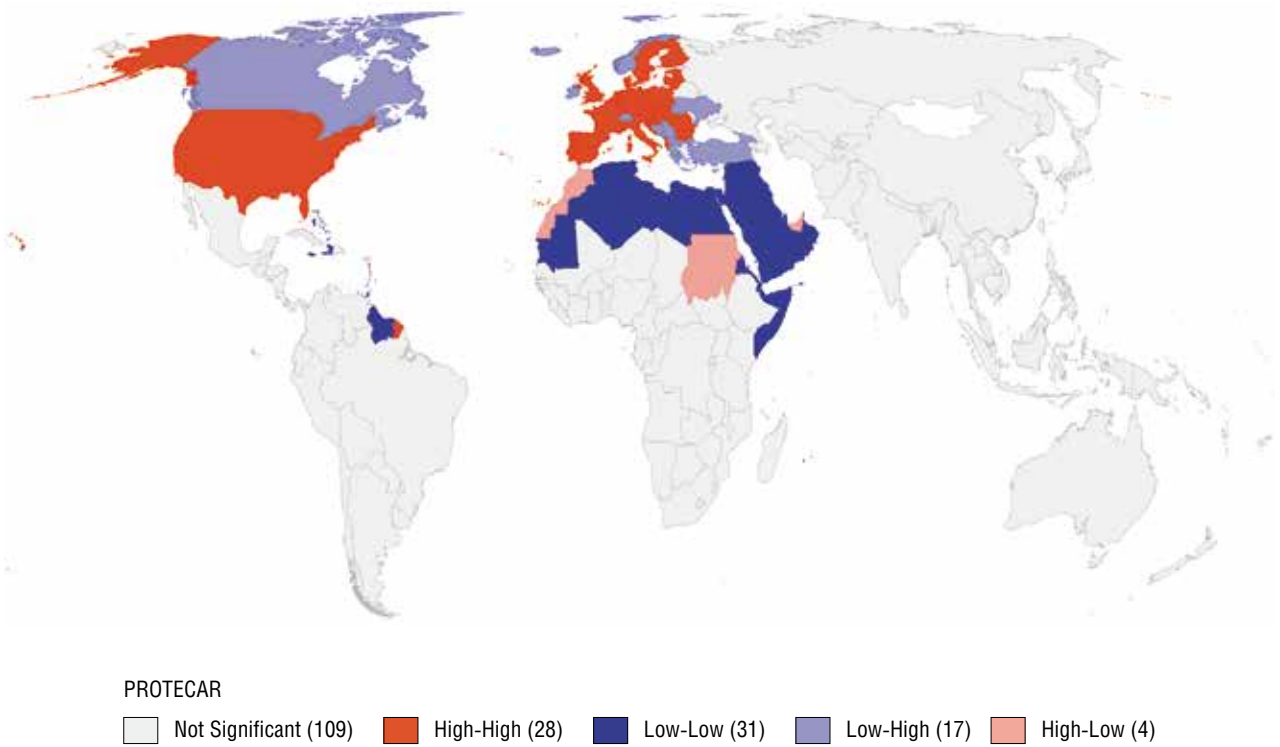


Fig. 11.3.4. “Conservation areas” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.4. Depletion of natural resources

Depletion of natural resources is defined as the combined net deforestation, energy depletion and mineral depletion expressed as a percentage of gross national income (GNI). It is used as an indicator of human intervention in the natural environment and the destruction of the ecological balance.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.258	0.000	0.149	0.000
Geary's C	0.718	0.000	0.846	0.000

The percentile cartogram (Fig. 11.4.1) shows us that the territories that scored high on this indicator occupy a large portion of the globe: much of South America, Africa, Oceania, and Asia (including Russia). The depletion of natural resources is highest in those countries whose economic development largely relies on the use of these resources. Conversely, the countries that scored the lowest on this indicator have economies that are based on the services sector and resource-intensive hi-tech manufacturing. Natural resource depletion is worst in sub-Saharan Africa, which reflects a worrying trend towards the destruction of the region's unique ecosystems.

The average value for all countries is more than ten times lower than the highest value. This speaks to the fact that, in most countries, the depletion of natural resources is not as critical as the percentile cartogram would indicate. The lowest scores for this indicator are observed in the island states, as well as in the developed countries of Europe.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.4.3) reveals a low-value cluster that is located in the territory of the most developed countries in Europe: France, Germany, Belgium, Austria and Switzerland. This is due to the fact that the service sector occupies a prime position in the structure of the economies of these countries, and the latest resource-saving technologies and renewable energy sources are used in industrial manufacturing, while agriculture and

Global place	Country	Indicator (% of GNI)
1	Congo	45.8
2	Guinea	31.9
3	Oman	24
Mean (63)	(Tajikistan)	4.3283 (4.2)
Median(84–89)	India, China, Comoro Islands, Pakistan, North Macedonia, Philippines	1
124–130	Jordan, Cape Verde, Costa Rica, Moldova, Turkey, Finland, Sweden	0.2
131–137	Austria, Greece, Israel, Ireland, Italy, Portugal, Central African Republic	0.1
138–173	Bahamas, Barbados, Belgium, Vanuatu, Germany, Dominica, Iceland, Spain, Cyprus, Kiribati, South Korea, Latvia, Lebanon, Lithuania, Luxembourg, Mauritius, Maldives, Micronesia, Monaco, Nauru, Palau, Panama, Samoa, São Tomé and Príncipe, Seychelles, Saint Vincent and the Grenadines, Saint Lucia, Singapore, Slovakia, Slovenia, Sudan, Tonga, France, Switzerland, Sri Lanka, Japan	0

production — activities that impose the greatest burden on the natural habitat — are not central to the national economy. Two more clusters can be observed in Africa: a high-value cluster southwest of the Sahara; and another cluster in Central Africa. At the same time, Cameroon and the Central African Republic are “errors” that demonstrate lower-than-expected values, since the economic situation in these countries is extremely unstable, which leads to the decline of manufacturing activities that use natural resources as raw materials.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 11.4.4) includes a greater number of countries in these clusters. The European cluster, which includes only a few countries in the geographical matrix, is joined by all NATO and EU member states. The only exception here is Norway, which has a higher percentage of depleted natural resources compared to its neighbours, a likely consequence of the country’s reliance on the oil and gas industry and hydropower. India, Pakistan and Bangladesh form another cluster of low natural resource depletion rates. The countries of the Economic Community of Central African States make up a high-value cluster of natural resource depletion. Cameroon, Central African Republic, Benin, and Senegal “drop out” of the cluster. The geopolitical neighbourhood matrix clearly demonstrates: 1) the division of the world into countries whose economic development is based on the exploitation of natural resources and the services sector; and 2) the relative homogeneity of countries that are part of political and economic associations in terms of the degree to which their natural resources have been depleted.

The likelihood-ratio test for geometry and natural resource depletion (Fig. 11.4.2) in this case identifies countries with similar economic structures: economies based on oil and raw materials (for example, in Latin America, the Middle East and Central Asia); the resource-intensive highly developed economies of European countries; and states where the low levels of consumption of natural resources are most likely caused by their relatively poorly developed manufacturing industries (for example, in the countries of sub-Saharan Africa and Oceania).

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Conflictogenity	0.027	0.047	0.178	1.173
2	Maternal mortality	0.078	0	0.272	0.949
3	Number of doctors	0.056	0.002	−0.229	0.936
4	Linguistic diversity	0.093	0	0.286	0.88
5	Particulate air pollution	0.086	0	0.268	0.835
6	Access to electricity	0.094	0	−0.28	0.834
7	GDP (PPP) per capita	0.034	0.016	−0.168	0.83
8	Alcohol consumption	0.056	0.002	−0.209	0.78
9	Infant mortality	0.122	0	0.306	0.768
10	Years at school	0.078	0	−0.241	0.745

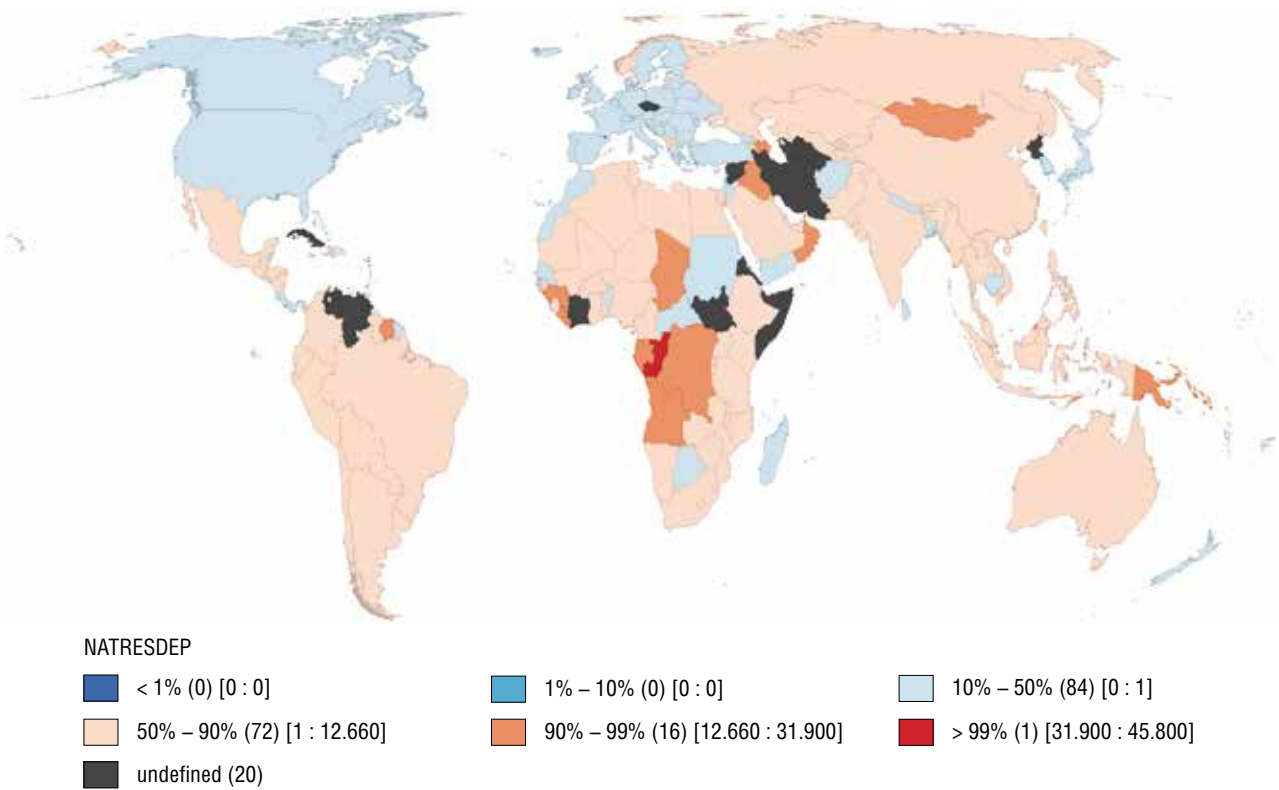


Fig. 11.4.1. Percentile cartogram for the “Depletion of natural resources” indicator

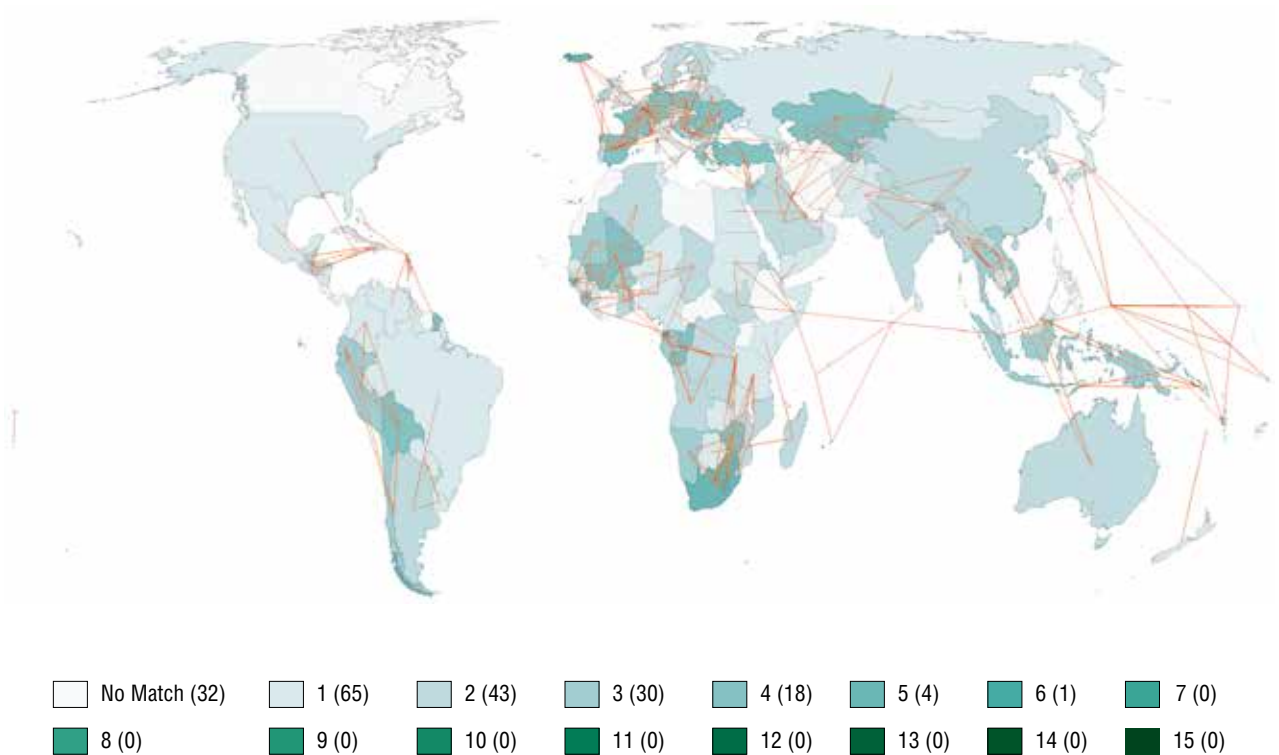


Fig. 11.4.2. Likelihood-ratio test for the “Depletion of natural resources” indicator

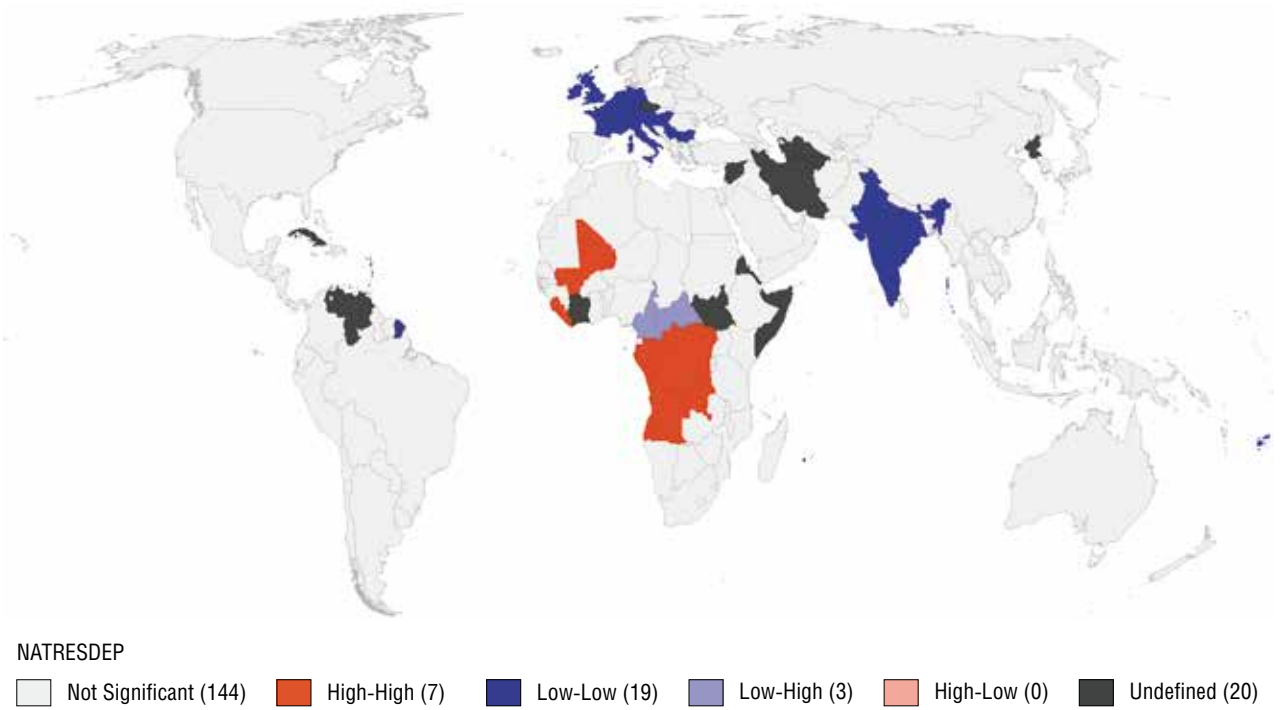


Fig. 11.4.3. “Depletion of natural resources” spatial autocorrelation cartogram for the geometric neighbourhood matrix

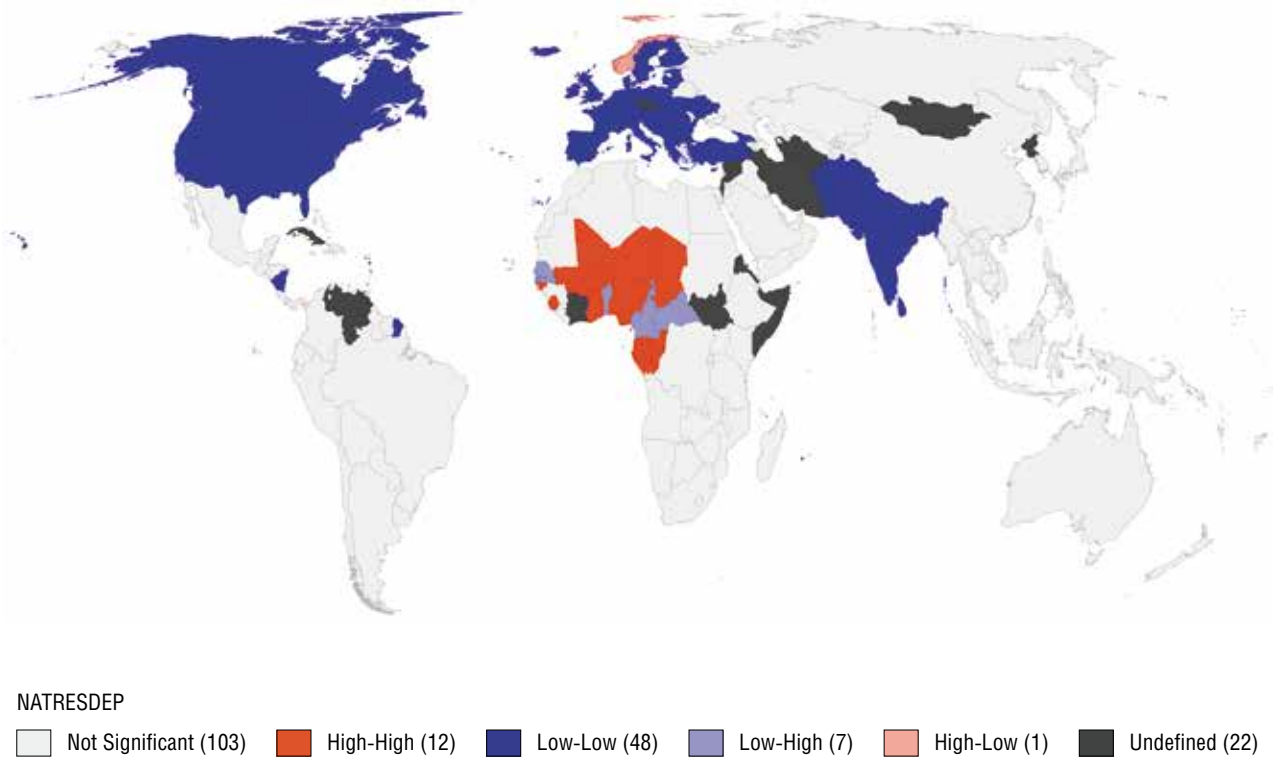


Fig. 11.4.4. “Depletion of natural resources” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.5. Fresh water

Fresh water is calculated as the difference between the total volume of fresh water supplied by the water industry and the losses of fresh water incurred during transport. This indicator is vital for describing the quality of the water component of the human environment and assessing the degree of industrial pollution of fresh water obtained from natural sources.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	-0.025	0.806	-0.007	0.570
Geary's C	1.88	0.841	1.003	0.570

The percentile cartogram (Fig. 11.5.1) gives us primarily high values. However, there are simply not enough observations for us to draw any clear conclusions. The biggest difference in the total volume of fresh water supplied by the water industry and the losses of fresh water incurred during transport is observed in Fiji, an island nation where the main source of water is rain, since obtaining fresh water from reservoirs and lakes is not possible due to the fact that they are located in inaccessible mountainous areas. Other countries that scored high on this indicator include Mali and Mexico, both of which have an arid climate, although both have impressive reserves of fresh water in underground sources. The low scores recorded for Monaco, the Maldives and Antigua and Barbuda indicate that a significant proportion of the clean fresh water supplied by their water supply systems is lost during transportation, a possible indication that the water supply infrastructure in these states is not up to scratch.

The small number of observations meant that none of the neighbourhood matrices produced any noticeable clusters, only isolated cases. The likelihood-ratio test for geometry and fresh water (Fig. 11.5.2) gives us more information about potential neighbourhood clusters, as it shows the number

Global place	Country	Indicator (million cubic metres)
1	Fiji	72,810
2	Mali	14,211
3	Mexico	12,441
Mean (15)	Zimbabwe	2967 (2889)
Median (31)	Qatar	495
60	Maldives	6
61	Monaco	5
62	Antigua and Barbuda	4

of physical neighbours may score similarly for this indicator. A noticeable prerequisite for clustering is present in South-eastern Europe, the Middle East, West and Central Africa, the Caribbean and South America.

Below, we list five pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Diplomatic missions	0.241	0.033	0.458	0.87
2	Budget deficit	0.121	0.033	-0.196	0.317
3	Film industry	0.115	0.03	0.159	0.22
4	Conflictogenity	0.179	0.001	0.157	0.138
5	Gender parity at school	0.144	0.012	0.056	0.022

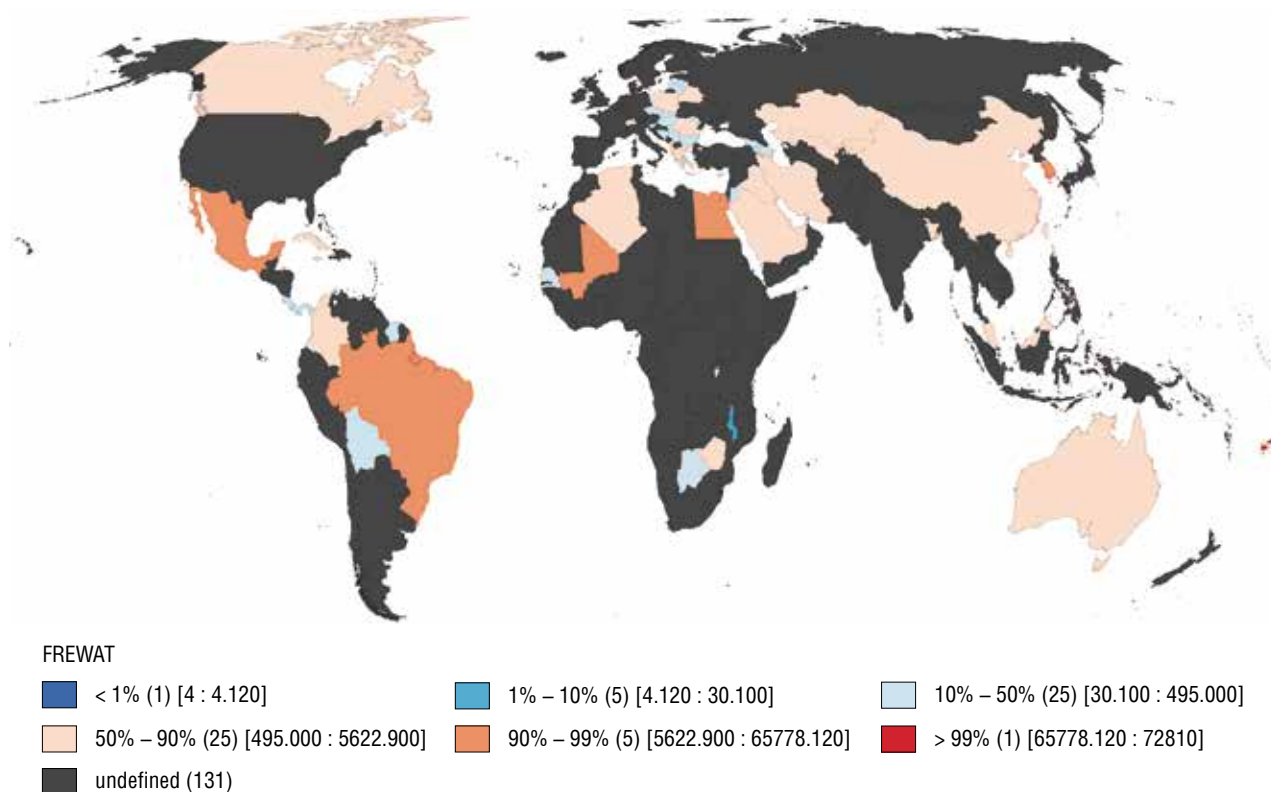


Fig. 11.5.1. Percentile cartogram for the “Fresh water” indicator

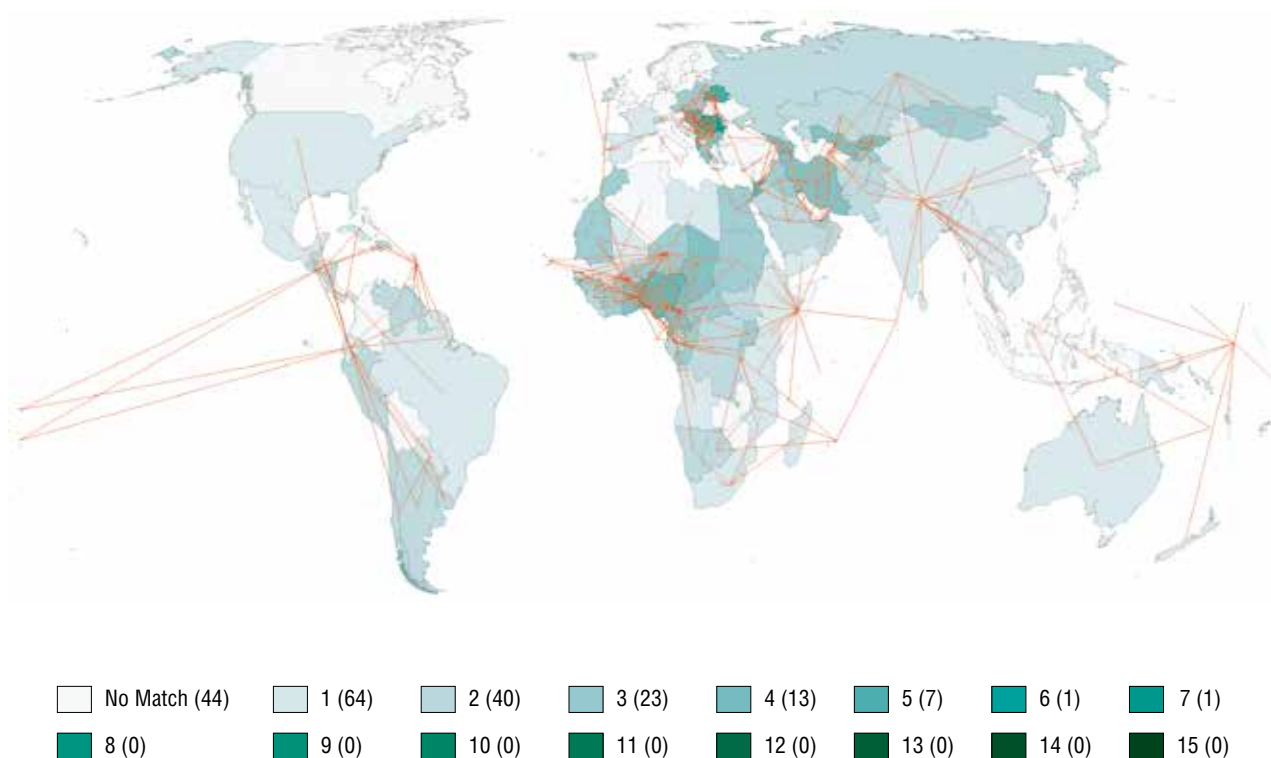


Fig. 11.5.2. Likelihood-ratio test for the “Fresh water” indicator

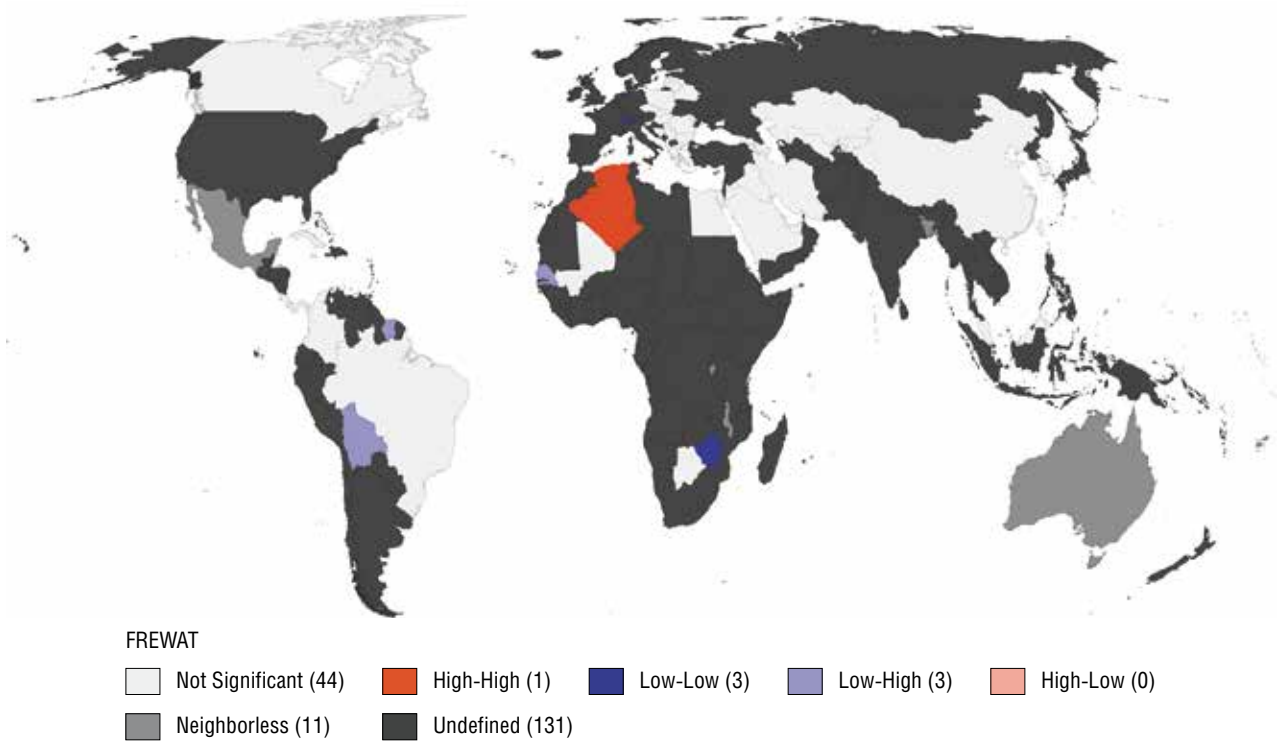


Fig. 11.5.3. “Fresh water” spatial autocorrelation cartogram for the geometric neighbourhood matrix

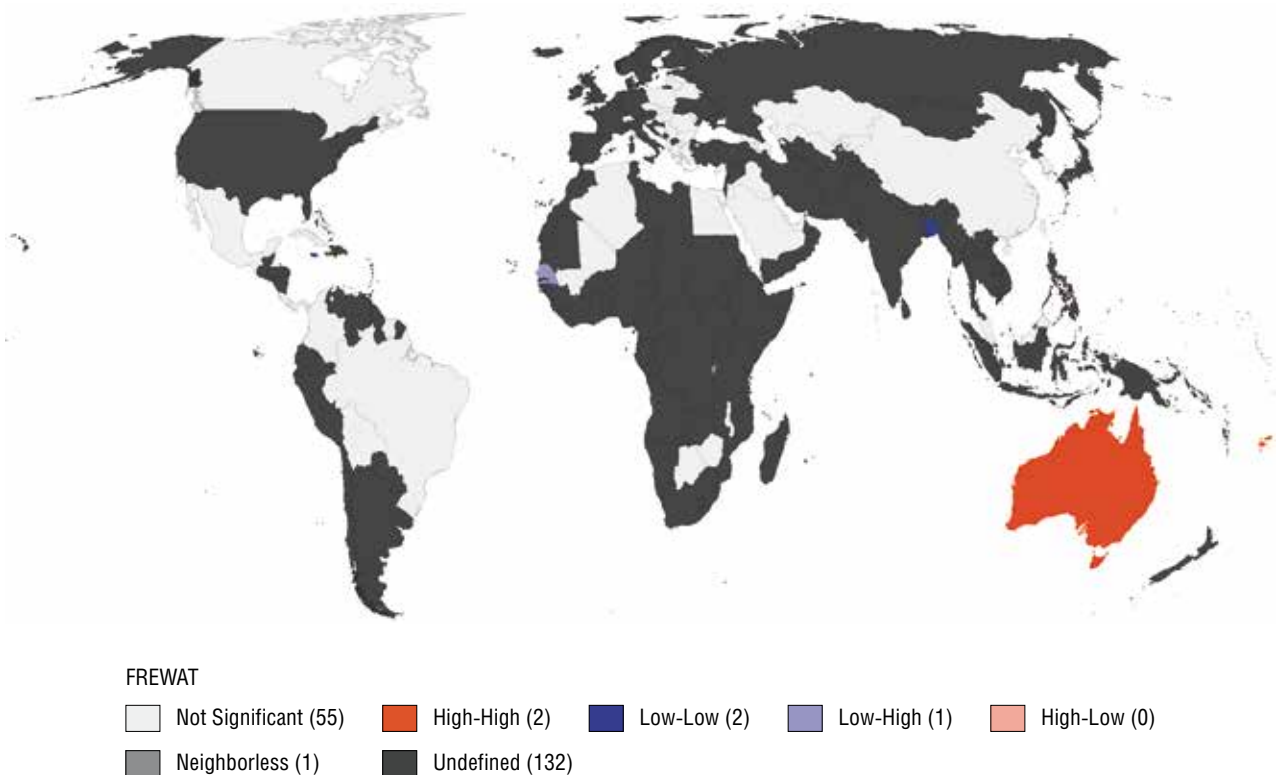


Fig. 11.5.4. “Fresh water” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.6. Renewable energy

Renewable energy is calculated as the share of electricity produced from renewable sources as a percentage of all electricity generated by all types of power plants in the country. This indicator allows us to assess both the potential harm of electricity generation and the level of development of environmentally friendly technologies for electricity generation.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.280	0.000	0.232	0.000
Geary's C	0.700	0.000	0.764	0.000

The percentile cartogram (Fig. 11.6.1) shows a slight spread for this indicator, which suggests that renewable energy is developing relatively uniformly in different regions of the world. There is not a single case where less than 1% of a country's electricity is produced using renewable sources, for example. The countries with the highest share of renewable energy in their energy balance are small states with a rather complex structure of human settlement (hard-to-reach mountainous areas, tropical forests, etc.) and where renewable makes it possible to provide electricity to remote areas. For example, in Nepal, many households are fitted with biogas units for the supply of electricity. And hydroelectric power is used on a large scale in Albania, Lesotho and Bhutan, with electricity being generated using a system of dams and mountain rivers. Iceland, which also uses hydroelectric power, is actively developing geothermal energy. This is a consequence of the country's geographic features and terrain, with numerous geysers and volcanoes providing a source of thermal energy.

Global place	Country	Indicator (%)
1–4	Albania, Lesotho, Nepal, Paraguay	100
2	Bhutan	99.99
3	Iceland	99.98
Mean (79)	(Luxembourg)	32.6594 (32.38)
Median (97)	Vanuatu	21.2598
166	Brunei	0.05
167	Botswana	0.03
168–193	Antigua and Barbuda, Bahamas, Barbados, Bahrain, East Timor, Guyana, Gambia, Guinea-Bissau, Grenada, Djibouti, Yemen, Qatar, Comoro Islands, Kuwait, Liberia, Libya, Monaco, Oman, Palau, San Marino, Saudi Arabia, Saint Lucia, Somalia, Trinidad and Tobago, Turkmenistan, Chad	0

A large number of economically underdeveloped countries are not engaged in the production of electricity from renewable sources. These include countries in North and Central Africa and the Middle East, as well as small island states in Asia and South America.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.6.3) highlights a number of large clusters. Note in particular the high-value clusters in South America and sub-Saharan Africa. Most likely, the development of environmentally “clean” energy production technologies in the countries of these regions is driven by the need to provide remote settlements with high-quality and affordable electricity. These countries also have unique flora and fauna, which may contribute to reducing CO₂ emissions generated by the use of “traditional,” which is to say non-renewable, sources of energy. A significant low-value cluster is located in North Africa and the Middle East, a consequence of the reliance of the economies and energy sectors of these countries on oil production and processing.

On the whole, the spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 11.6.4) gives us more or less the same patterns as the cartogram for the geometric neighbourhood matrix, but in a somewhat expanded format, as it takes both nearest neighbours and more distant ones into account. Ethiopia is a good example of this.

Likelihood-ratio test for geometry and renewable energy (Fig. 11.6.2) shows that renewable energy has developed evenly in South Africa and the Arabian Peninsula. A similar situation is observed in Europe, which is explained by the pan-European policy of promoting carbon neutrality and clean energy.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Conservation areas	0.026	0.026	0.17	1.112
2	Highly wealthy population	0.044	0.009	0.193	0.847
3	Women in politics	0.065	0	0.224	0.772
4	Female population	0.041	0.006	0.155	0.586
5	Petrol prices	0.044	0.007	0.158	0.567
6	Military spending	0.095	0	-0.213	0.478
7	Economic inequality	0.054	0.004	0.156	0.451
8	Deposit	0.064	0.001	-0.16	0.4
9	Access to electricity	0.025	0.028	-0.098	0.384
10	Particulate air pollution	0.03	0.027	-0.104	0.361

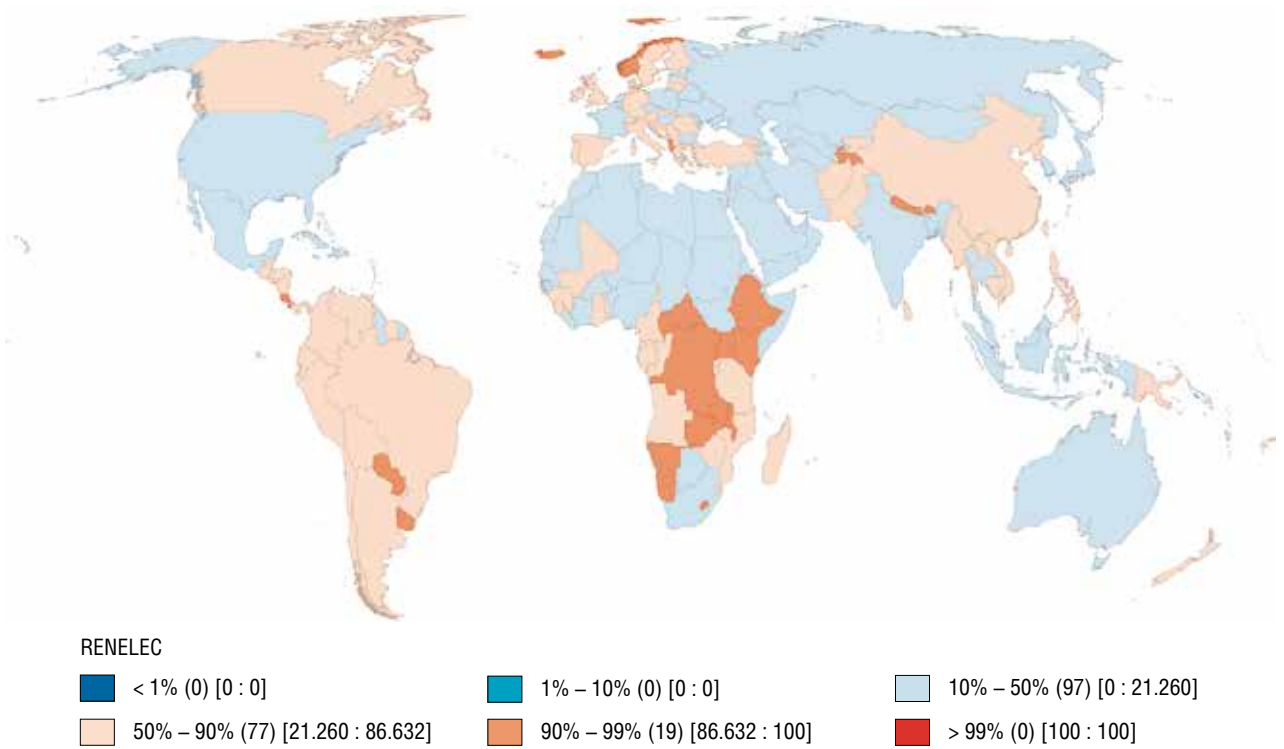


Fig. 11.6.1. Percentile cartogram for the “Renewable energy” indicator

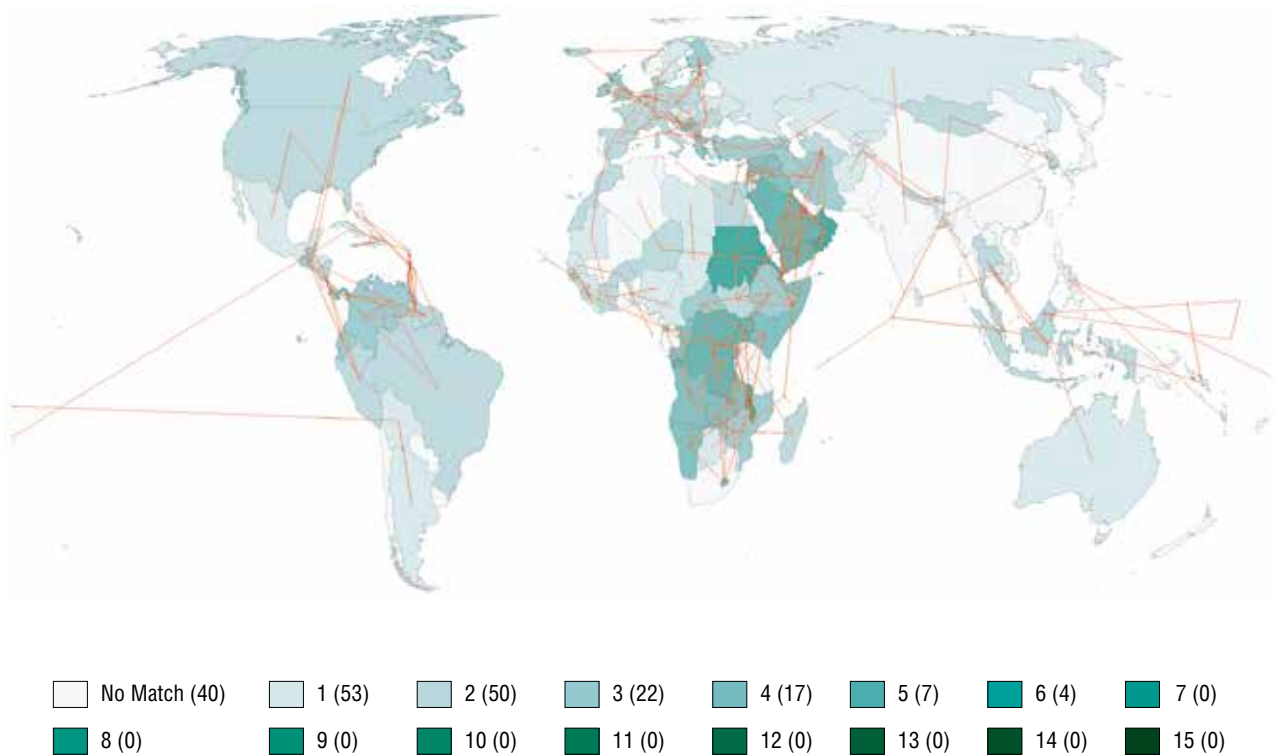


Fig. 11.6.2. Likelihood-ratio test for the “Renewable energy” indicator

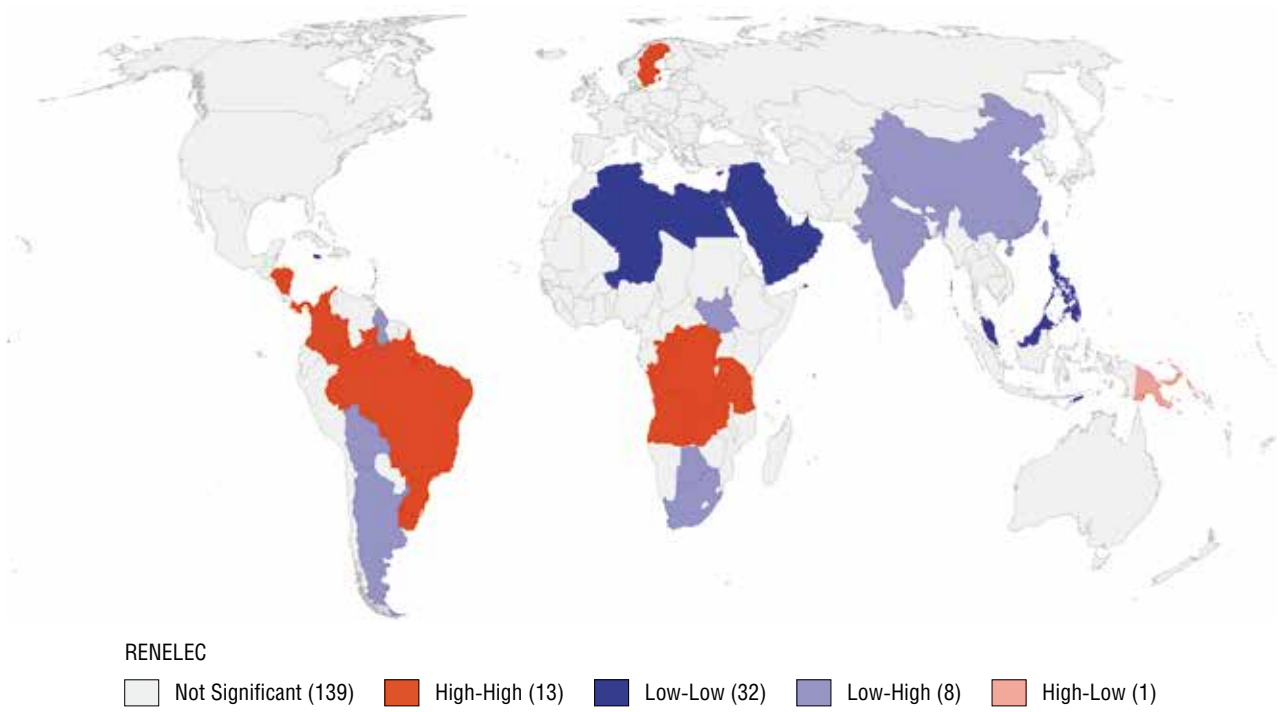


Fig. 11.6.3. “Renewable energy” spatial autocorrelation cartogram for the geometric neighbourhood matrix

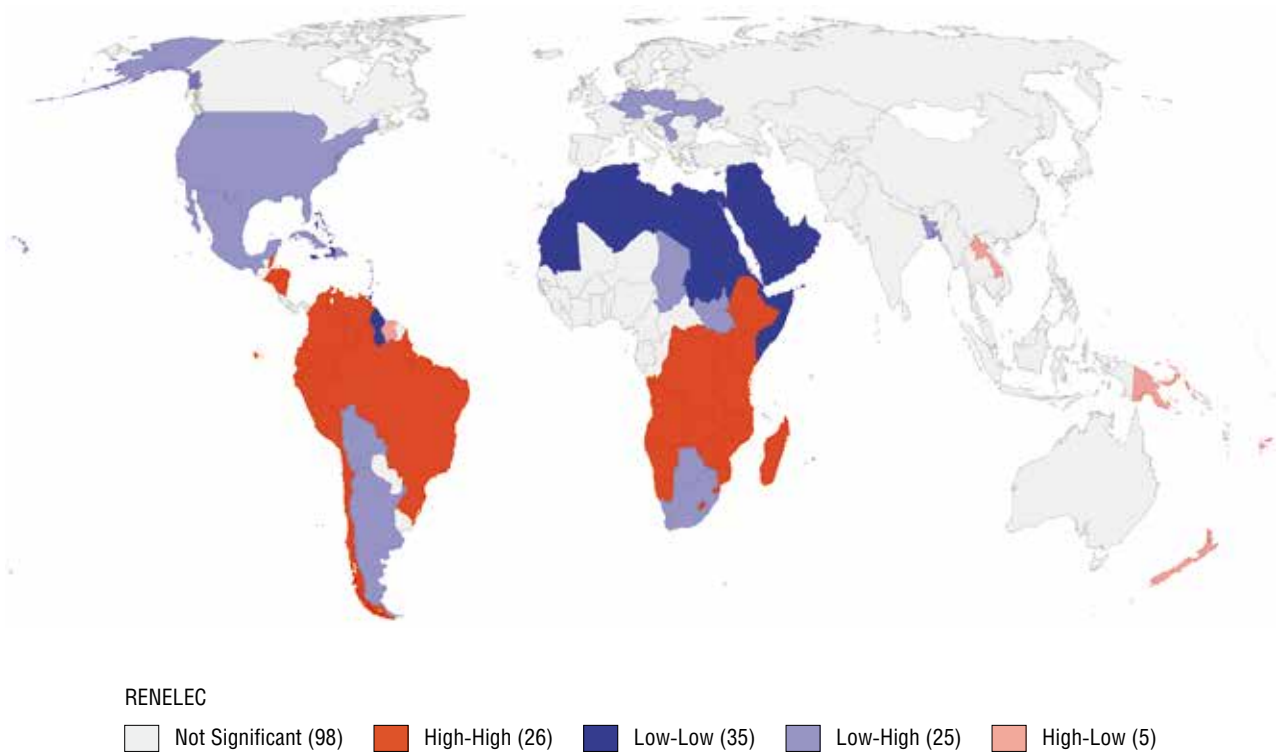


Fig. 11.6.4. “Renewable energy” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.7. Availability of electricity

Availability of electricity is calculated as the sum total of electricity production and imports, minus exports, per capita. It allows you to determine how much electricity people living in the country receive and assess the level of development of electricity supply in the country.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.401	0.000	0.199	0.000
Geary's C	0.566	0.000	0.797	0.000

The percentile cartogram (Fig. 11.7.1) shows that there is wide variation in the level of electricity supply across the globe. The leaders here are the most economically developed countries — the United States, China, Canada and Australia. Iceland and Norway are also among the top countries in terms of the availability of electricity due to the wide variety of sources at their disposal and the fact that they have adapted methods for generating energy to their unique terrains and climatic conditions (and both countries have relatively small populations): much of Iceland's electricity, for example, is produced using geothermal energy.

The cartogram clearly shows that African countries are lagging behind in terms of electrification, which can be explained by their poorly developed economies. We should also note the significant spread of values for this indicator: the leading countries have tens of thousands of kilowatts of energy per capita, compared to a few dozen kilowatts at best in the poorest countries with unstable economies.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.7.3) reveals several notable clusters. Notably, Russia falls into the European cluster of high values due to its proximity to the countries of Northern Europe. However, the Eastern European former Soviet countries that neighbour

Global place	Country	Indicator (kWh)
1	Iceland	57,426
2	Norway	25,294
3	China	19,845
Mean (61)	(Saint Kitts and Nevis)	3920.6789 (3919)
Median (96–97)	(Grenada, Belize)	2099.5 (2102; 2097)
189	Somalia	24
190	Guinea-Bissau	21
191	Chad	15

Russia and Western Europe did not fall into this cluster. Low-value clusters are found in the so-called “poverty zones” — sub-Saharan Africa, where most of the population lives in extreme poverty and does not have access to electricity.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 11.7.4) gives us almost the exact same low-value clusters, the only difference being that the “poverty zone” also includes Pakistan and Afghanistan, India and Bangladesh, populous countries that are members of the South Asian Association for Regional Cooperation. In Africa, it includes most of Southern Africa, excluding Republic of South Africa, which is one of the most industrialized countries on the continent. There are two high-value clusters, one that is made up of countries located in the Western Hemisphere — the United States and Canada, and another that includes all the countries of Europe. Notably, the European cluster contains a large number of exceptions: Latvia, Ukraine, Romania, Turkey, Albania and Macedonia are behind their neighbours in terms of electricity supply.

The likelihood-ratio test for geometry and the availability of electricity is most pronounced in Europe, South America and Oceania, as well as in two sub-regions of Africa — West Africa and East Africa.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Royalties to foreign copyright holders	0.057	0.003	0.301	1.589
2	Cultural solidarity	0.032	0.025	0.205	1.313
3	Foreign assets	0.045	0.02	0.237	1.248
4	Linguistic diversity	0.034	0.011	-0.194	1.107
5	Inbound tourism	0.059	0.002	0.233	0.92
6	Number of doctors	0.191	0	0.388	0.788
7	IMF voting power	0.074	0	0.241	0.785
8	Women in politics	0.031	0.015	0.154	0.765
9	Payments to foreign investors	0.089	0	0.26	0.76
10	Regional trade agreements	0.158	0	0.346	0.758

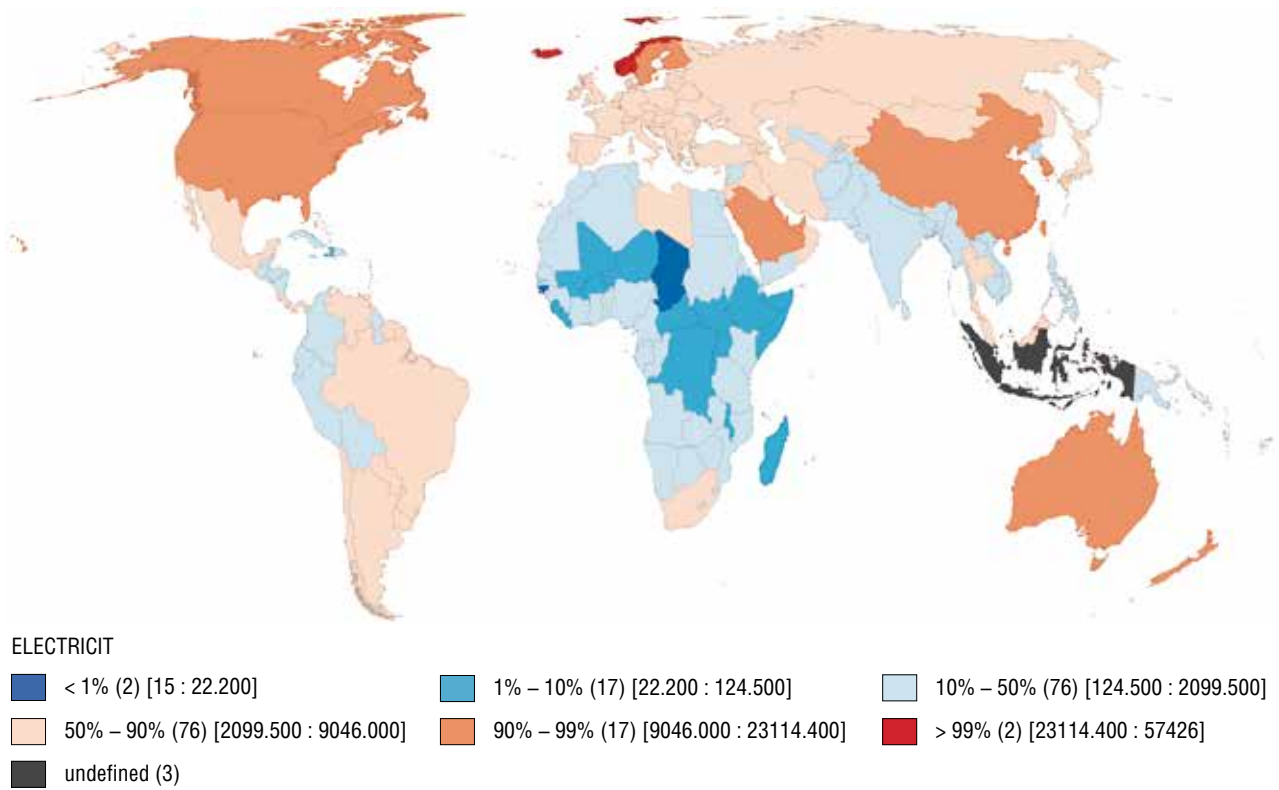


Fig. 11.7.1. Percentile cartogram for the “Availability of electricity” indicator

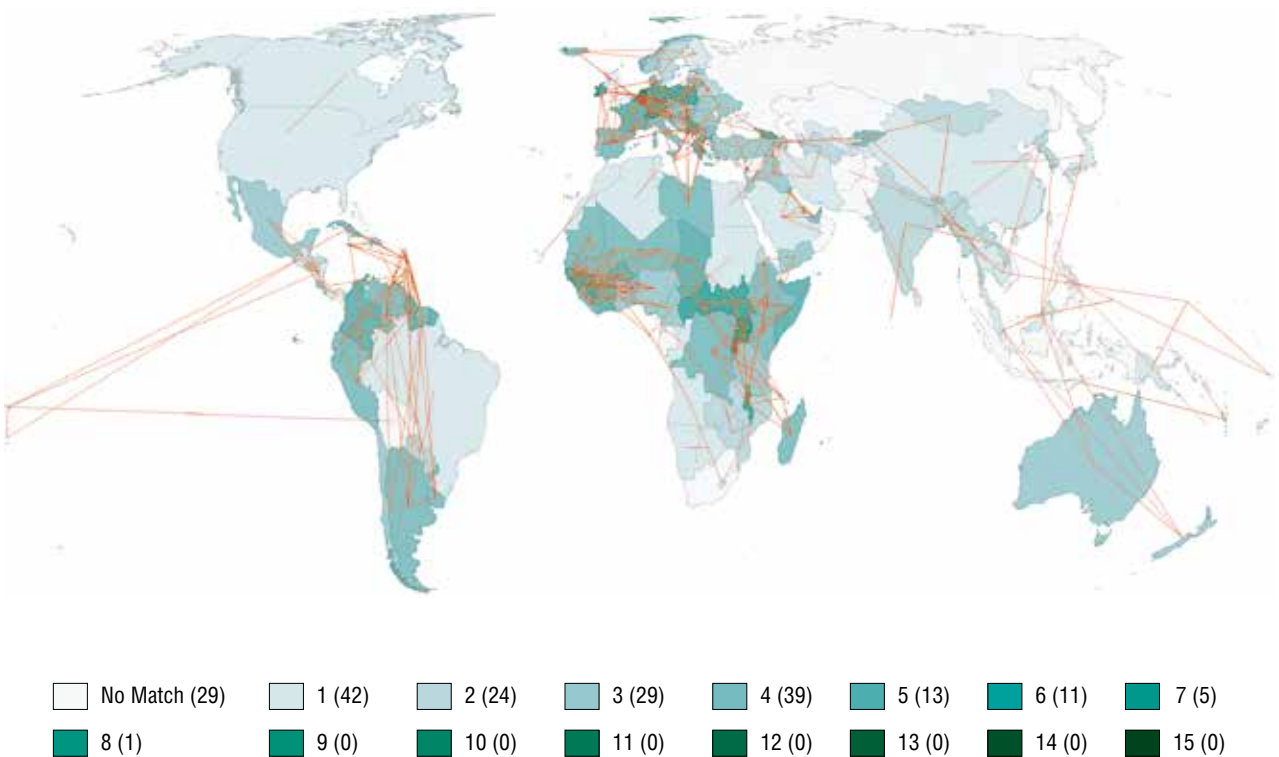


Fig. 11.7.2. Likelihood-ratio test for the “Availability of electricity” indicator

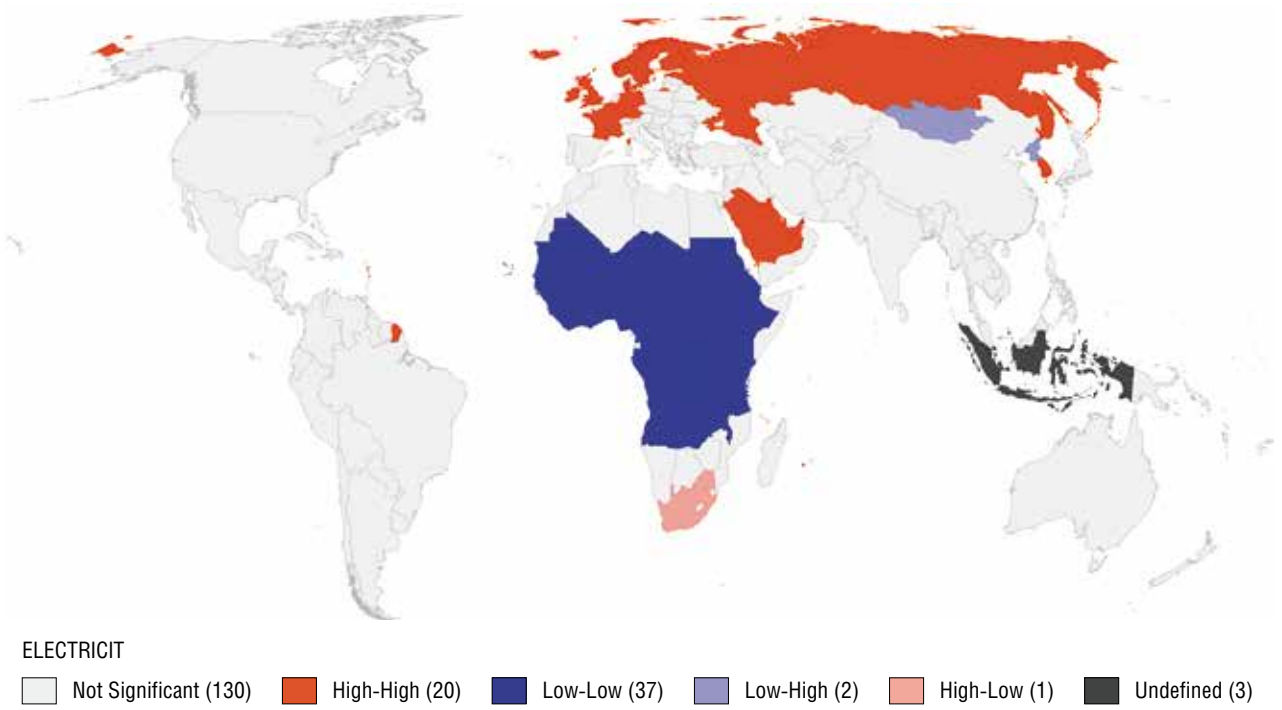


Fig. 11.7.3. “Availability of electricity” spatial autocorrelation cartogram for the geometric neighbourhood matrix

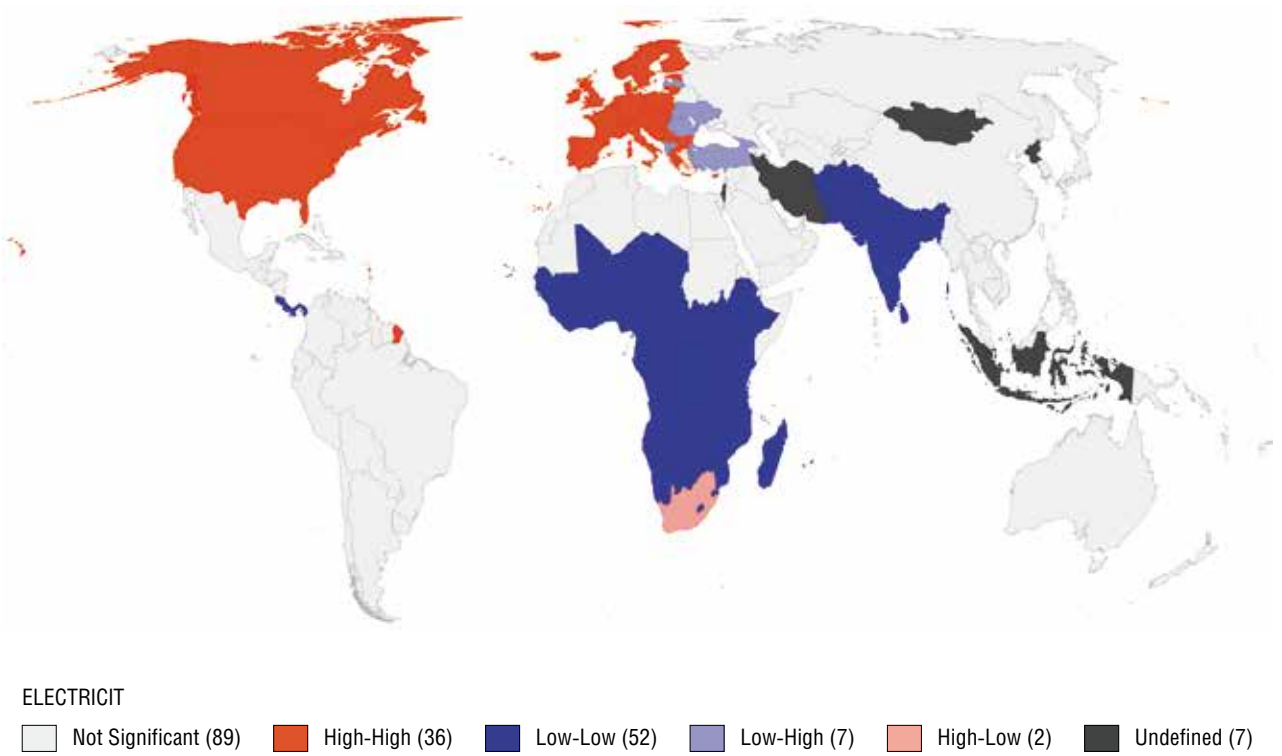


Fig. 11.7.4. “Availability of electricity” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.8. CO₂ emissions

CO₂ emissions are calculated as the total volume of carbon dioxide released into the atmosphere from the consumption of liquid, solid or gas fuels per capita. The indicator is used as a baseline for assessing the state of the environment, since it can be used to determine the purity of atmospheric air and the scale of potential greenhouse effects (the main cause of climate change).

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.456	0.000	0.138	0.000
Geary's C	0.508	0.000	0.858	0.000

The percentile cartogram in Fig. 11.8.1 shows a fairly large spread of high and low values for this indicator. It is worth noting that high levels of CO₂ emissions are evident in countries with a high level of industrial development, such as the United States, China, Russia and Canada, as well as in the Middle East, whose economies depend on the extraction and processing of oil, the two industries that are most harmful to the environment as they produce huge amounts of carbon dioxide emissions. The lowest values for this indicator are in Central Africa, where subsistence farming is the most common form of economic activity, and which is characterized by a low level of industry. The low CO₂ emissions are thus explained not by an effective state policy aimed at reducing the total volume of carbon dioxide released into the atmosphere, but rather by the absence of conditions that would produce such emissions.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.8.3) reveals a large cluster of low values that includes all of sub-Saharan Africa, where, as we mentioned earlier,

Global place	Country	Indicator (tonnes per capita)
1	Qatar	38.9
2	Trinidad and Tobago	31.84
3	Kuwait	24.95
Mean (67)	(Sweden)	4.3928 (4.36)
Median (94)	Egypt	2.5259
183–184	Central African Republic, Chad	0.07
185–186	Burundi, Somalia	0.05
187	Democratic Republic of the Congo	0.03

subsistence farming dominates, meaning low CO₂ emissions. The high-value cluster of the countries of the Middle East and the Arabian Peninsula is notable. High-value clusters are made up of large industrial countries, most notably the United States and Russia, whose emissions are obviously orders of magnitude greater than those of neighbouring states.

The spatial autocorrelation cartogram for the geopolitical neighbourhood matrix (Fig. 11.8.4) shows that Europe has a high level of CO₂ emissions. There are outliers here, however, namely Latvia, Switzerland, Croatia, Albania, and Romania, where emissions are low, unlike their neighbours. Low-value clusters are also visible in South Asia (which includes India, Pakistan and Afghanistan) and Central America, which in both cases may be due to the fact that industry is not particularly developed in these countries and that the level of urbanization there is also low. Another reason is the predominance of rural areas in these regions, meaning that CO₂ emissions cannot be high. And, in the case of India, the high population, which levels out the parameter values for the country, is also a factor.

The likelihood-ratio test for geometry and CO₂ emissions per capita (Fig. 11.8.2) reveals that the prerequisites for clustering exist in East Africa, South America and Europe, which points to the relatively uniform development of these regions. It should be noted that there was no significant correspondence in the scores for this parameter among the NAFTA countries, indicating that the member countries produce wildly different amounts of CO₂ emissions.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Motorways	0.029	0.019	0.163	0.916
2	Population growth	0.016	0.089	-0.112	0.784
3	IMF voting power	0.065	0	0.201	0.622
4	Regional trade agreements	0.043	0.004	0.16	0.595
5	Maternal mortality	0.155	0	-0.303	0.592
6	Royalties to foreign copyright holders	0.061	0.002	0.189	0.586
7	Infant mortality	0.205	0	-0.345	0.581
8	Access to electricity	0.159	0	0.304	0.581
9	Export	0.079	0	0.213	0.574
10	Inbound tourism	0.054	0.003	0.172	0.548

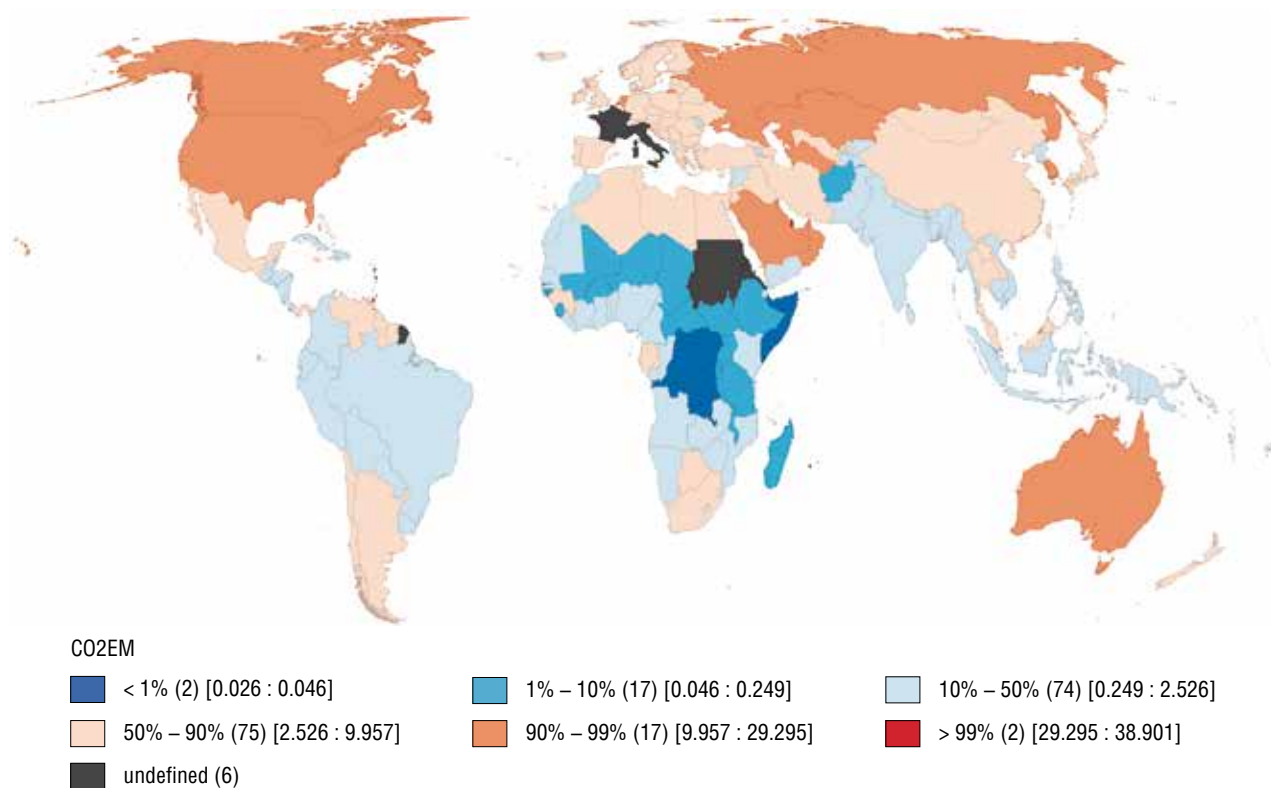


Fig. 11.8.1. Percentile cartogram for the “CO₂ emissions” indicator

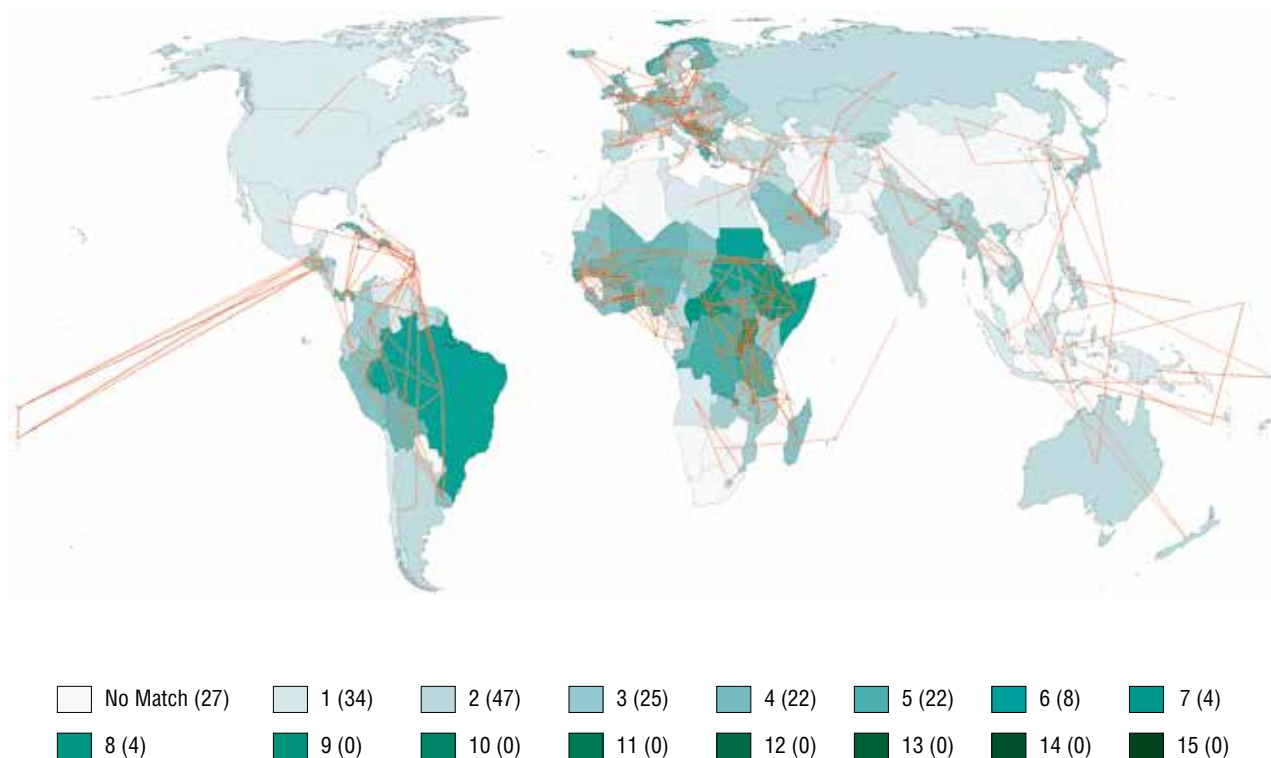


Fig. 11.8.2. Likelihood-ratio test for the “CO₂ emissions” indicator

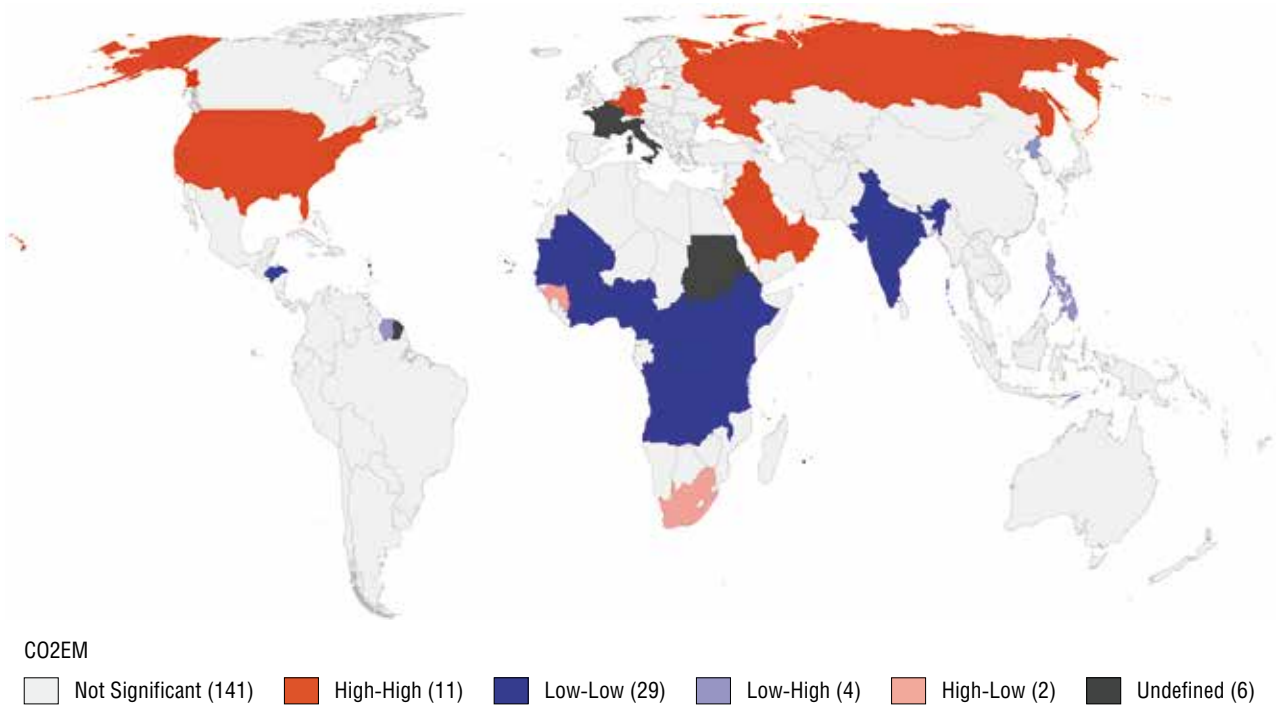


Fig. 11.8.3. “CO₂ emissions” spatial autocorrelation cartogram for the geometric neighbourhood matrix

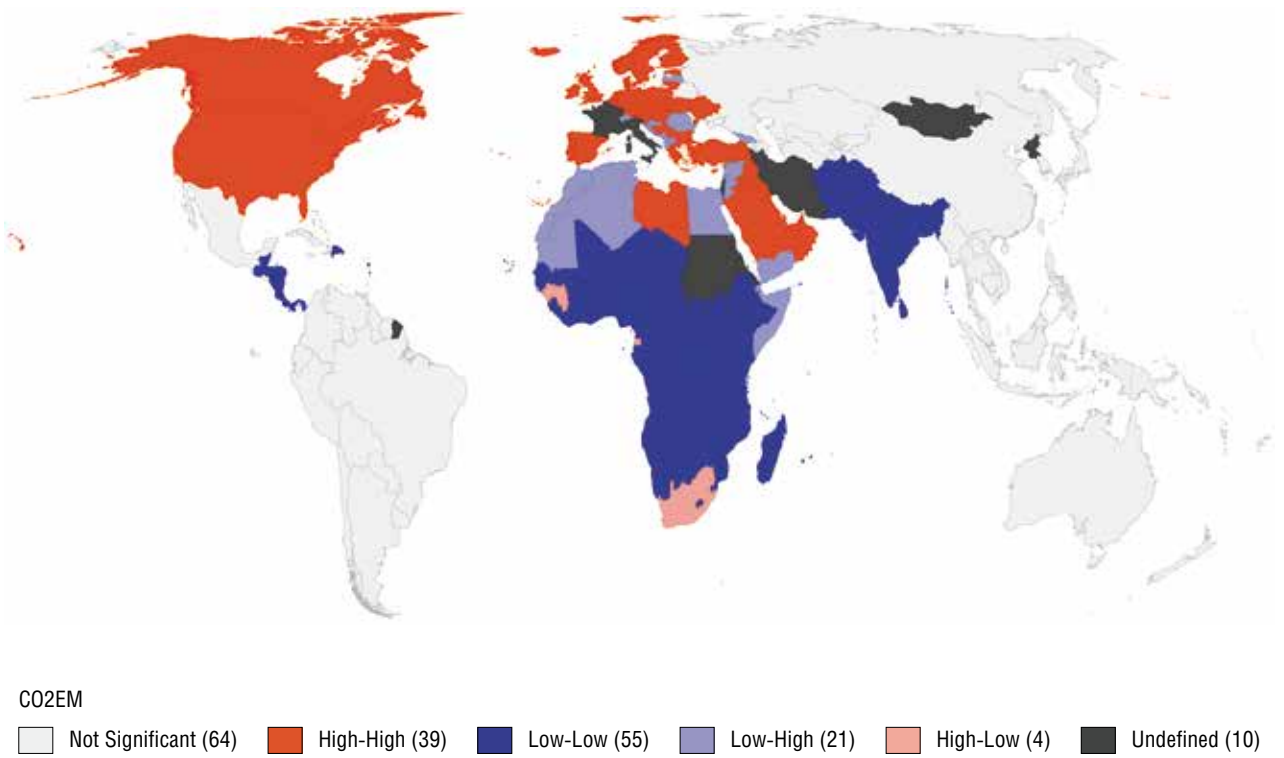


Fig. 11.8.4. “CO₂ emissions” spatial autocorrelation cartogram for the geopolitical neighbourhood

11.9. Particulate air pollution

Particulate air pollution (particulate matter less than 2.5 microns) is calculated as the average annual exposure of the population to PM_{2.5} emissions per cubic metre of air. It is used to determine the anthropogenic load on the environment and reflects the degree to which the atmosphere is polluted with particles that are hazardous to the health of the human respiratory tract.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.680	0.000	0.546	0.000
Geary's C	0.332	0.000	0.452	0.000

The percentile cartogram (Fig. 11.9.1) gives us a generally optimistic picture of the situation, as most regions of the world scored relatively low. There are, however, notable exceptions, for example Asia and Africa. The global leaders in this indicator are India and its neighbour Nepal. According to the World Health Organization, 11 of the 12 most polluted cities are located in India. Without a doubt, the polluted air adversely affects the health of the people living in these countries, and is one of the main factors of infant mortality there. The main sources for such high levels of air pollution are industrial production (coal, soot products, heavy metal compounds, etc.), as well as street and construction dust in large cities, agricultural technologies used to burn the lower layers of cereal crops, and natural factors (such as forest fires). The lowest levels of air pollution are observed in Scandinavia and the Baltic states — countries known for their proactive environmental policies focused on the “green” economy.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.9.3) reveals a number of noticeable clusters. First of all, we should note the high-value cluster in North and West Africa,

Global place	Country	Indicator ($\mu\text{g}/\text{m}^3$)
1	India	83.3
2	Nepal	82.8
3	Niger	80.1
Mean (61)	(Lebanon)	28.8528 (29)
Median (81)	Colombia	22.5
159	Estonia	5.9
160	Sweden	5.7
161	Finland	5.6

which is understandable given the desert climate of these countries. Other high-value clusters have appeared in the Arabian Peninsula and Iran on account of the arid climate and the abundance of sand. The high-value cluster includes India and China — the countries with developed coal industries. As for low-value clusters, the one in Western and Northern Europe (regions that have implemented low-carbon policies) is particularly noteworthy, most likely due to their vast forest areas.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.9.4) gives us more clusters. North and South America make up low-value clusters, as they too have vast forest (and rainforest) areas. The cluster centred in India extends to Pakistan and Afghanistan, which brings it closer to the Middle Eastern and North African clusters, almost merging with them.

The likelihood-ratio test for geometry and “Particulate air pollution” (Fig. 11.9.2) shows a number of noticeable similarities around the world. Note first of all the pattern of European integration, as well as the similar levels of air pollution in the USA and Canada. Oceania and the Caribbean also demonstrate similar levels of air pollution.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson’s C and Moran’s I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran’s I	Spatial effect index
1	Military spending	0.04	0.013	0.238	1.416
2	IMF voting power	0.028	0.036	−0.183	1.196
3	Conservation areas	0.025	0.044	−0.169	1.142
4	Women in politics	0.098	0	−0.317	1.025
5	Linguistic diversity	0.227	0	0.453	0.904
6	Depletion of natural resources	0.086	0	0.274	0.873
7	Petrol prices	0.103	0	−0.295	0.845
8	Population growth	0.287	0	0.49	0.837
9	Suicide rate	0.113	0	−0.306	0.829
10	Rate of gross accumulation	0.037	0.016	0.175	0.828

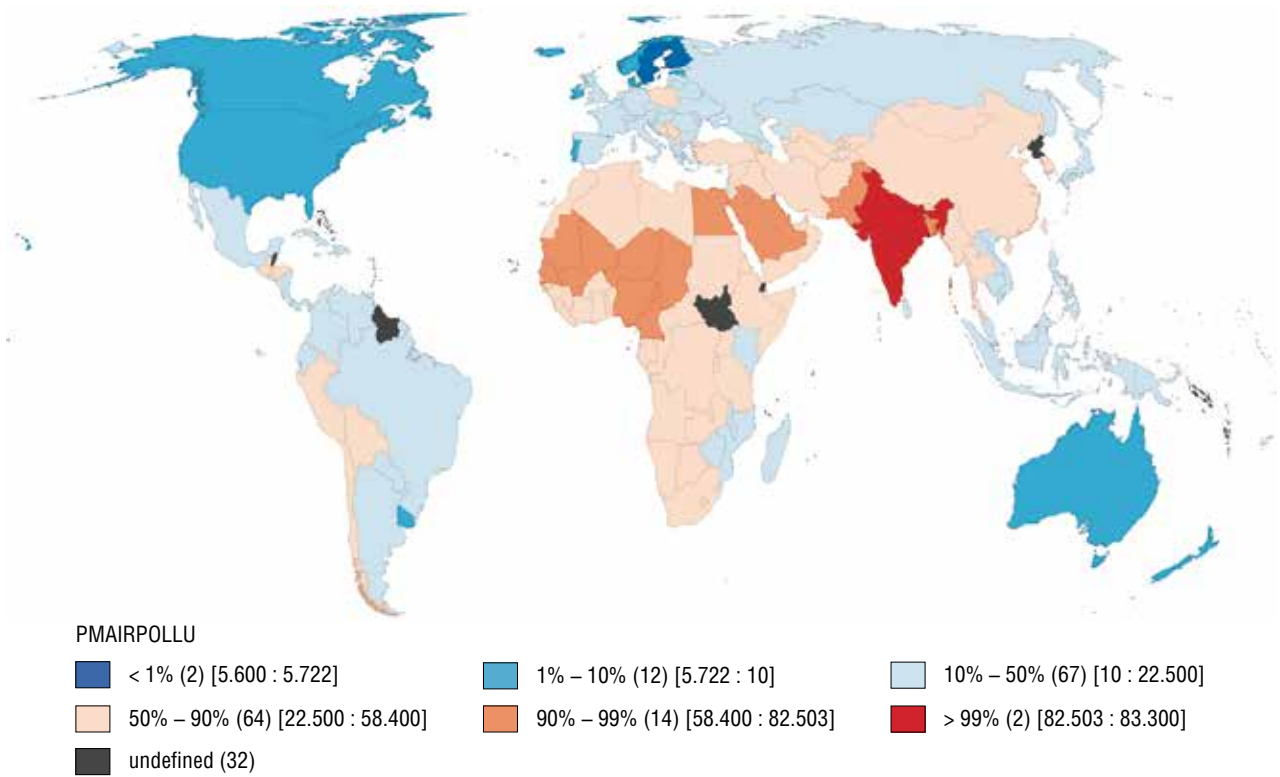


Fig. 11.9.1. Percentile cartogram for the “Particulate air pollution” indicator

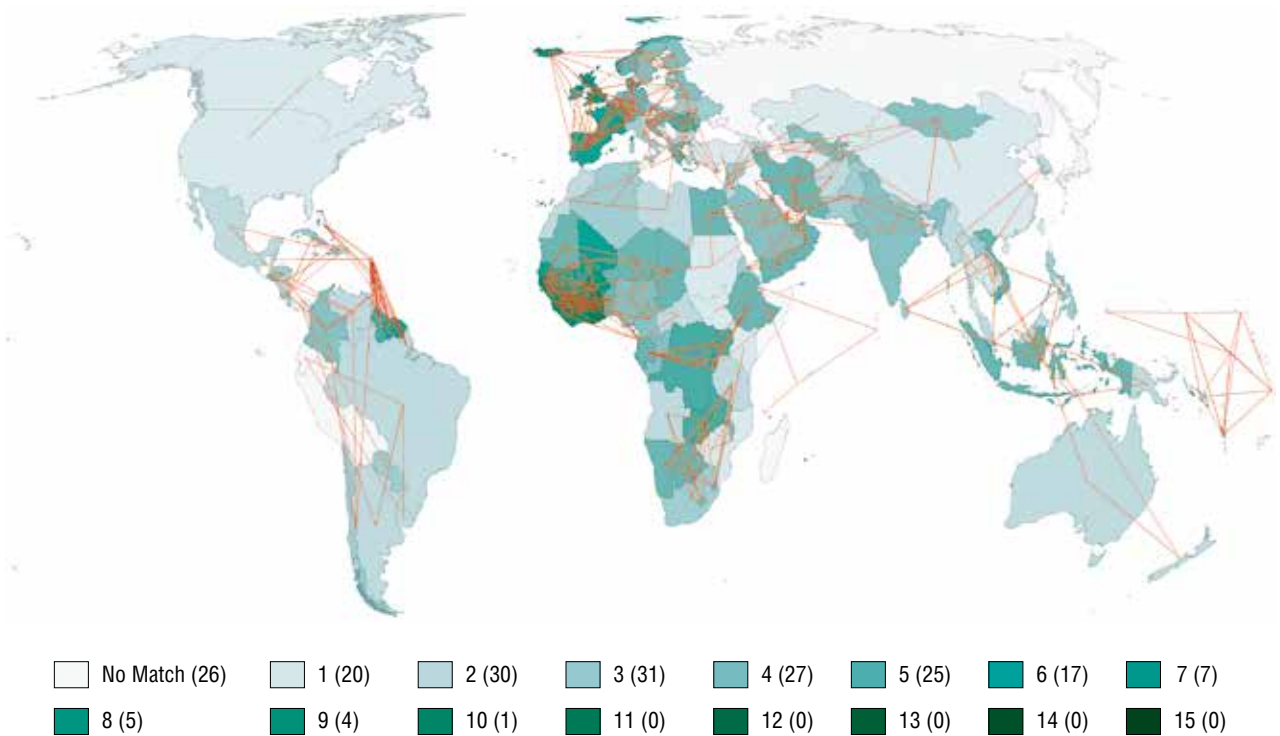


Fig. 11.9.2. Likelihood-ratio test for the “Particulate air pollution” indicator

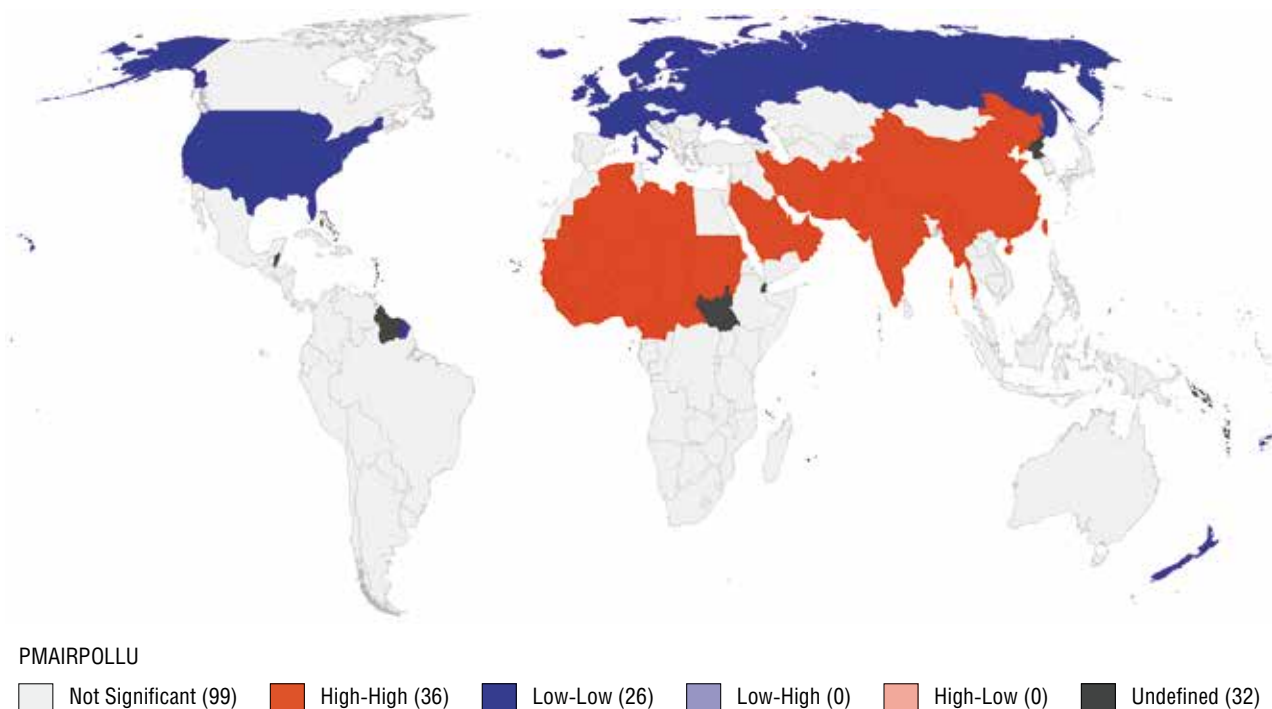


Fig. 11.9.3. “Particulate air pollution” spatial autocorrelation cartogram for the geometric neighbourhood matrix

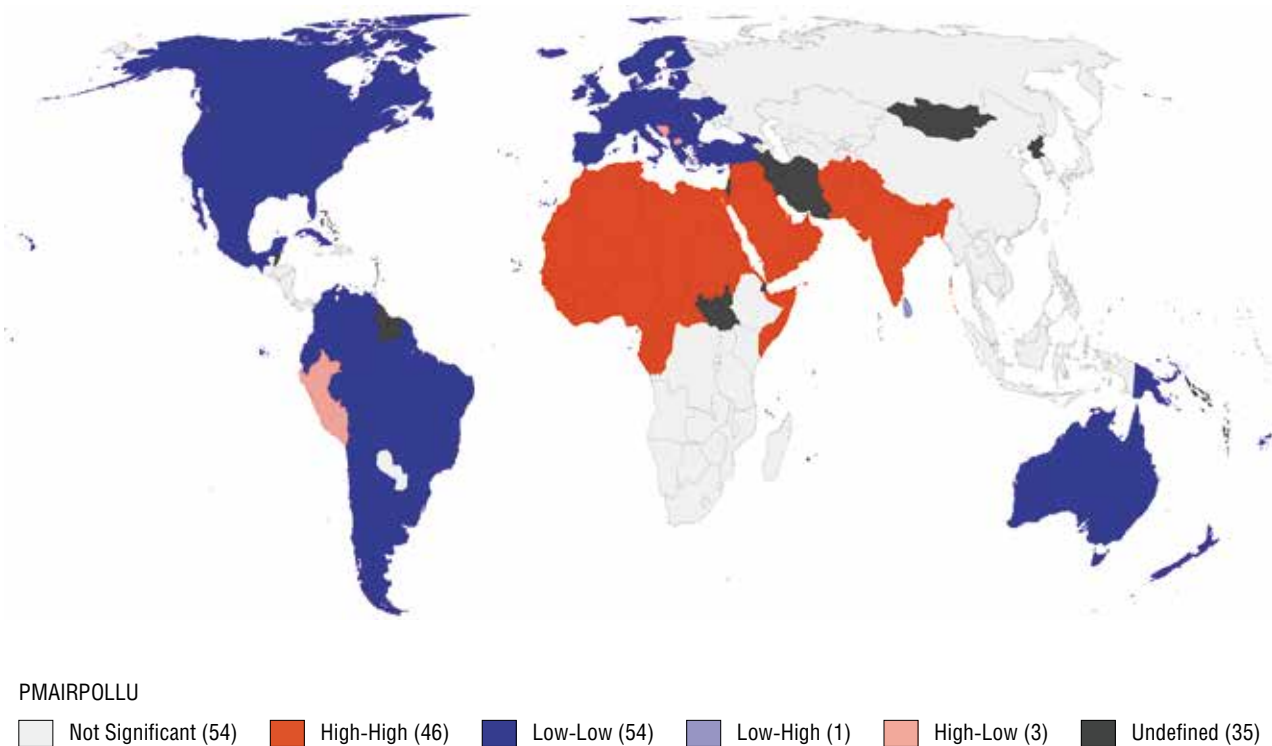


Fig. 11.9.4. “Particulate air pollution” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.10. Light pollution

Light pollution is calculated as the number of so-called “luminosity units” (magnitude) per arcsecond square and reflects the degree to which artificial light sources “illuminate” the lower layers of the atmosphere. Not only does excessive night-time illumination make astronomical observations difficult, but it also disturbs the biorhythms of all living beings — both humans and animals and plants that react to light. Light pollution is thus an important criterion for assessing the quality of the environment.

Spatial autocorrelation indices				
	Geometry	P-value	Geopolitics	P-value
Moran's I	0.185	0.000	0.016	0.192
Geary's C	1.018	0.555	0.979	0.192

The percentile cartogram for light pollution (Fig. 11.10.1) shows a preponderance of highly illuminated countries around the world, a result of global urbanization. Low levels of light pollution are observed in small island states (Kiribati, Tuvalu, Nauru) and countries that are mostly rural (Mongolia, the countries of West Africa and the Caribbean), where outdoor artificial lighting is not common. Most developed industrial countries (the United States, China, Russia, Brazil, France and India) have a high level of light pollution, although it is significantly lower in Germany and the countries of Eastern and Northern Europe. This is likely because there are large areas of sparsely populated land in these regions, almost no big cities (a major source of artificial light), and active environmental policies.

The geometric neighbourhood matrix yields a greater spatial correlation than the geopolitical matrix, and the hypothesis that the world's geopolitical structure has greater significance is thus not confirmed.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.10.3) reveals several significant clusters. The first cluster of note is a high-value cluster which includes Russia and Japan.

Global place	Country	Indicator (units of luminosity / second of arc ²)
1	United States	33,104,783
2	China	16,184,575
3	Russia	11,662,733
Mean (63)	(Mongolia)	142,260.43 (142,042)
Median (93–94)	(Costa Rica, Trinidad and Tobago)	163,620 (163,761; 163,479)
186	Kiribati	503
187	Nauru	495
188	Tuvalu	76

In the case of Russia, it demonstrates high level of light pollution compared to its neighbors. Mongolia scores low on this indicator, despite its proximity to China, and the same is true of North Korea in relation to the South. The high-value cluster also includes the USA, Canada and Mexico. What all this shows is that this indicator does not depend on the geographical position of countries relative to their neighbours, and that light pollution levels vary wildly around the world.

The spatial autocorrelation cartogram for the geometric neighbourhood matrix (Fig. 11.10.4) shows the absence of significant clusters for light pollution. Only a low-value cluster stands out in West Africa, which includes Nigeria with a high degree of urbanization and high values of the indicator. The situation is similar in the geopolitical bloc ANZUS and CU, where Australia demonstrates high values of the indicator compared to low values among its neighbors.

The likelihood-ratio test for geometry and light pollution (Fig. 11.10.2) gives us similar patterns to those produced by the cartograms, demonstrating that light pollution levels are more or less level in the Middle East, Eastern Europe and Oceania.

Below, we list ten pairings with the highest spatial effect index, i.e. with the greatest difference between the linear and the spatial correlations (Pearson's C and Moran's I) for the indicator under consideration.

No.	Indicator	Coefficient of determination	P-value	Two-factor Moran's I	Spatial effect index
1	Quality of school education	0.037	0.013	0.145	0.568
2	Maternal mortality	0.023	0.042	-0.111	0.536
3	Bioethical freedom	0.038	0.015	0.137	0.494
4	Access to electricity	0.029	0.02	0.118	0.48
5	Internet users	0.03	0.021	0.119	0.472
6	Infant mortality	0.029	0.021	-0.114	0.448
7	Life expectancy	0.029	0.023	0.114	0.448
8	Children	0.034	0.014	-0.118	0.41
9	Years at school	0.03	0.021	0.11	0.403
10	GDP (PPP) per capita	0.033	0.015	0.102	0.315

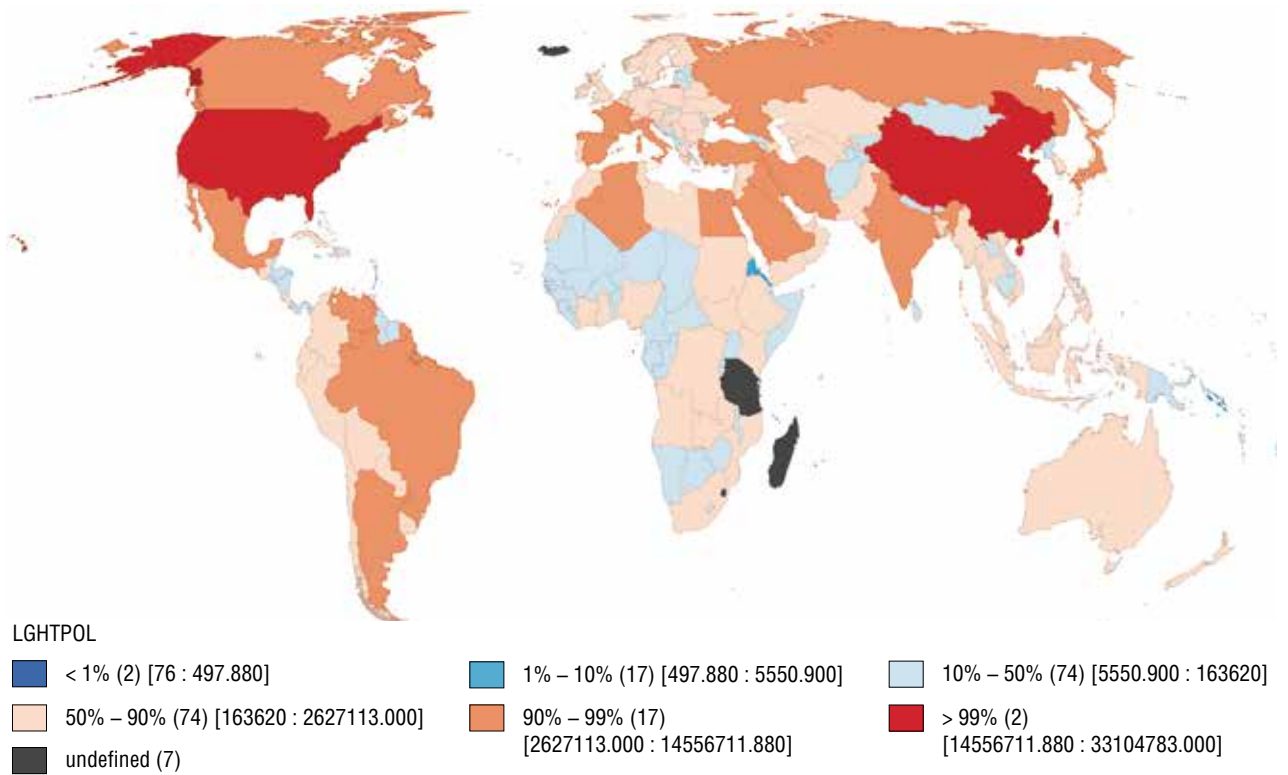


Fig. 11.10.1. Percentile cartogram for the “Light pollution” indicator

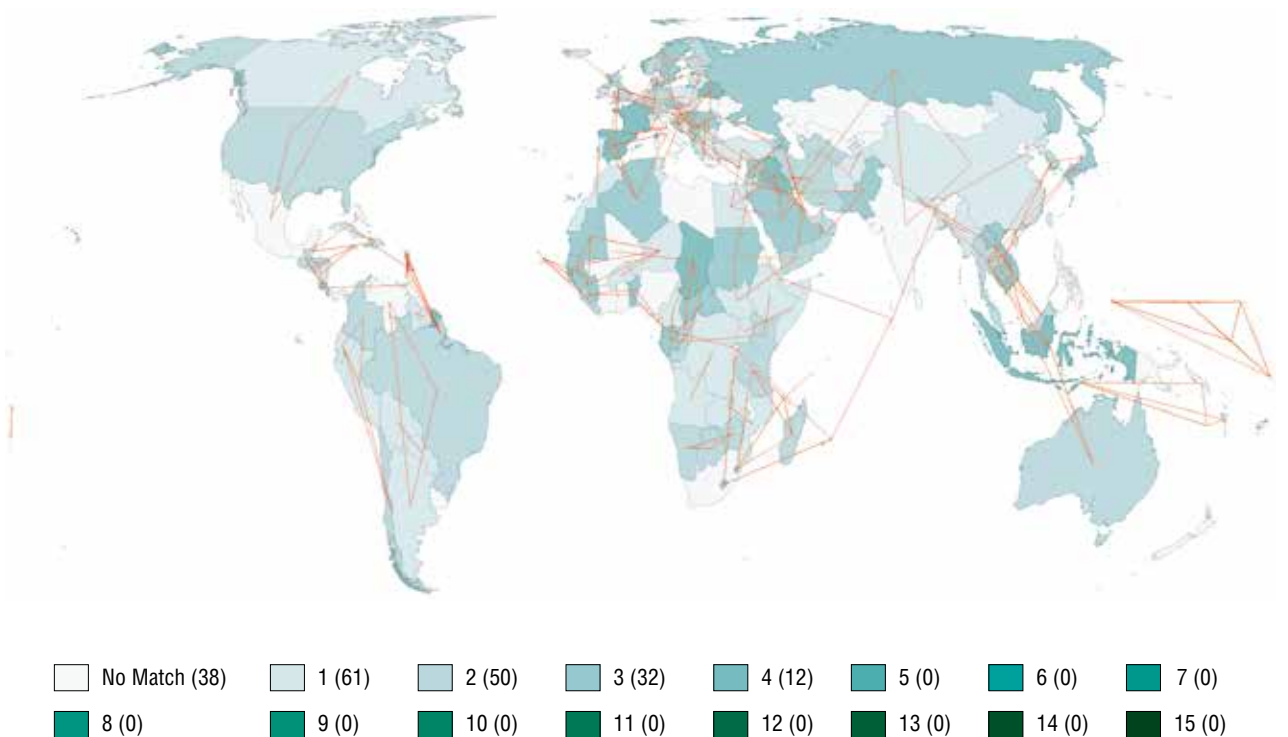


Fig. 11.10.2. Likelihood-ratio test for the “Light pollution” indicator

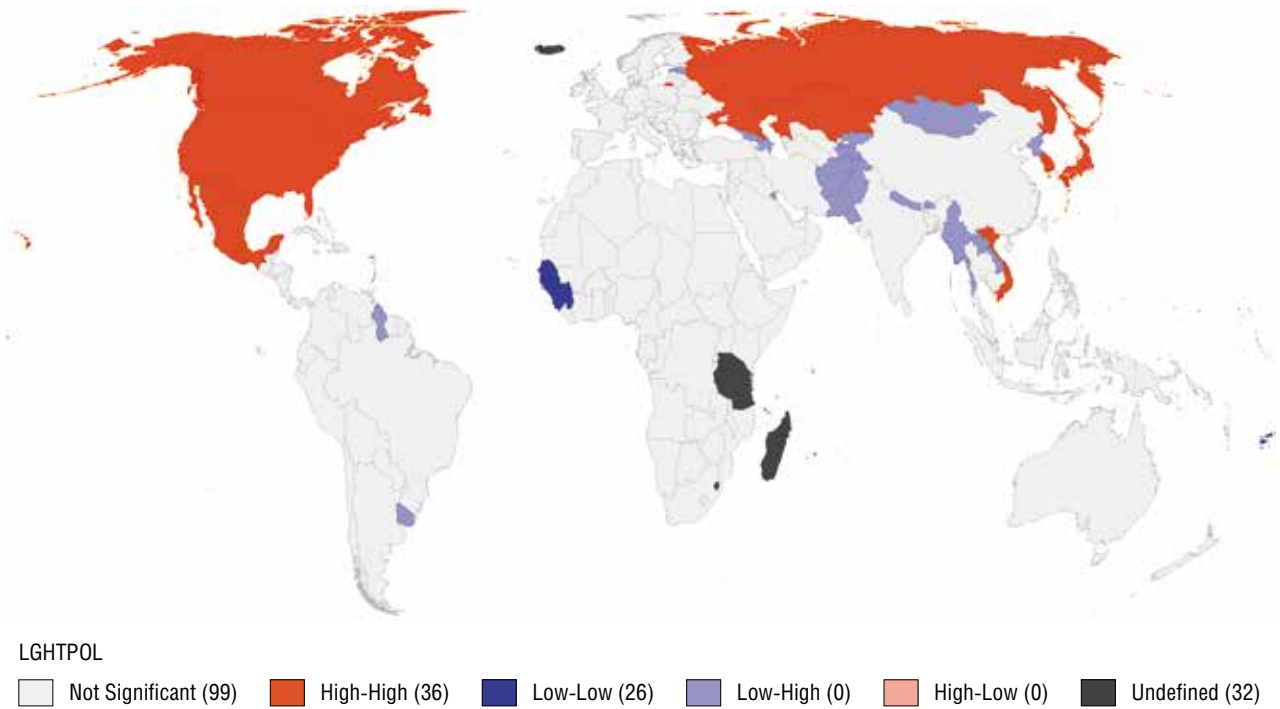


Fig. 11.10.3. “Light pollution” spatial autocorrelation cartogram for the geometric neighbourhood matrix

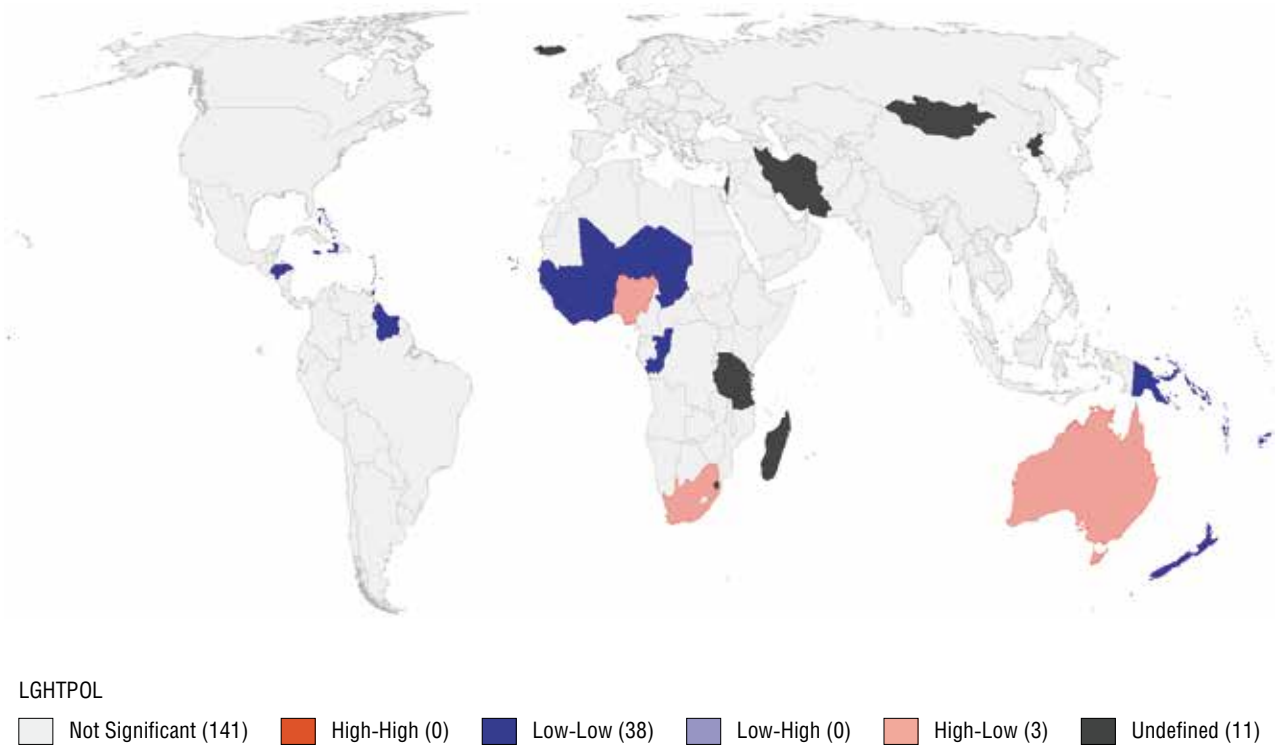


Fig. 11.10.4. “Light pollution” spatial autocorrelation cartogram for the geopolitical neighbourhood matrix

11.11. Multifactor analysis of the “Ecology” section indicators

The next step in assessing the ecological indicators described above is to carry out a multifactor analysis, which involves considering all ten parameters together. This includes an analysis of the geographic average, multifactor Geary's C, inverse spatial cluster analysis, and multidimensional scaling.

The biggest variance in the geographic average for this section is observed between CO₂ emissions, light pollution and depletion of natural resources.

The geographic average ellipse for the depletion of natural resources is skewed southwest compared to those for CO₂ emissions (per capita) and light pollution, which stretch to the northeast of Eurasia, closer to China, with the latter also tending towards the east coast of North America. This indicates that natural resources are being depleted to a greater degree in the developing countries of the Southern Hemisphere, where extensive farming dominates and concern for the environment is not as pronounced, while the industrial development and urbanization of the countries of the north is more likely to cause CO₂ emissions and light pollution.

The geographic average ellipses for CO₂ emissions and light pollution are positioned similarly compared to the depletion of natural resources, with both tending towards the Northern Hemisphere. At the same time, the geographic average of light pollution gravitates more towards the west (compared to CO₂ emissions), towards the countries of North America in particular, where the United States clearly dominates as the undisputed leader in this parameter. The geographic average of CO₂ emissions per capita is shifted eastwards relative to light pollution, towards Southeast Asia and Australia. The ellipses of these two indicators practically overlap in the northeast, indicating that the values for these parameters are distributed almost identically here.

An analysis of the geographic average ellipses by geopolitical bloc shows us that the biggest divergence among the indicators is in the spatial distribution of the share of CO₂ emissions and renewable energy.

In Europe and North America, for example, the ellipse for CO₂ emissions is skewed northwest, since industry is more developed there, air travel is widespread, and the level of car ownership is greater than in South-eastern Europe. The distribution of renewable energy use in the region is more even.

CO₂ emissions in the former Soviet countries are far higher than in other states, including Russia, the standard-bearer for the development of economic sectors that are responsible for CO₂ emissions. Meanwhile, the renewable energy ellipse has shifted significantly to the south. This can be explained by the fact that scores on these indicators are higher in countries with smaller territories and populations.

In East and Southeast Asia, the geographic average ellipse for CO₂ emissions is far more elongated from north to south than the energy ellipse, which suggests a more even distribution of the latter and higher values of the former in China and Japan — drivers of industry in the region. Note that both ellipses stretch from north to south.

A similar picture has formed in South America: despite the difference in the sizes of the region's geopolitical blocs, all noticeable ellipses are elongated from north to south in a similar direction.

A significant difference in ellipses is evident in the Middle East and North Africa. For example, the geographic average ellipse for CO₂ emissions is shifted towards the Arabian Peninsula, where some of the most polluted countries are located (a consequence of the development of the oil and gas industry), while the renewable energy ellipse stretches towards North Africa. This is most likely due to the fact that the countries of North Africa (Algeria, Tunisia, Egypt and Libya) do not typically produce energy using renewable sources, and the ellipse is thus pulled towards Morocco.

In the CIS countries, the geographic average ellipse for renewable energy is more west–east leaning, while the geographic average ellipse for CO₂ emissions tends more towards Russia, where mining and heavy industry based on coal are actively developed.

In this section, we analysed rather diverse and multifactorial indicators that can notionally be divided into two groups: parameters that reflect the scale of anthropogenic load on the environment (agricultural

territories, territories with high levels of light pollution, CO₂ emissions, natural resource depletion, etc.); and parameters that allow us to assess the environmental situation, or “resource availability” (fresh water, forest areas, renewable energy, availability of electricity, protected natural areas). As part of our analysis of the cartograms for multifactor Geary’s C, we suggest taking the indicators of one of these groups only into account, specifically, those that reflect the detrimental effect of human activity on the environment: the share of agricultural land; the degree of depletion of natural resources; the level of CO₂ emissions; particulate air pollution; and light pollution.

The spatial autocorrelation cartogram for multifactor Geary’s C for five indicators of anthropogenic load according to the geometric neighbourhood matrix (Fig. 11.11.1) gives us a notable cluster in South and East Asia. While China and India — countries with rapidly developing industries and massive populations — demonstrate a positive neighbourhood correlation due to the high level of environmental stress, the less industrialized countries that share a border with them (Bangladesh, North Korea and Mongolia) show a negative spatial correlation. A similar situation is observed in North America, where Mexico and Canada are negatively correlated with the neighbouring United States. There is a rather clearly defined European cluster that includes all of the most industrialized countries of the central, southern and western parts of the continent, but not those in the north, where state policy is geared towards development, the establishment of a “green economy” and minimizing human interference in the environment. Another cluster worthy of note is made up of Latin American countries on the Pacific coast (Chile, Peru and Ecuador), as is the cluster that stretches from the west of Africa (Mauritania and Mali) to the northeast of the continent (Egypt and Sudan) and the Arabian Peninsula (Saudi Arabia and the United Arab Emirates).

The cartogram for the geopolitical neighbourhood matrix (Fig. 11.11.2) reveals a cluster of positive correlations in South America, which includes the oil-producing countries of Brazil and Venezuela, as well as Colombia and Argentina, which have well-developed mining and metallurgy industries. However, the cartogram does not show any clustering by political integration blocs, which indicates that these environmental factors are due more to geographical reasons (the actual location of countries) than geopolitical reasons (the system of international relations of states).

Let us now move onto an inverse spatial cluster analysis of the “Ecology” indicators. This includes two cartograms: one adjusted for geographic proximity; and one not adjusted for geographic proximity.

The statistical clusters cartogram non-adjusted for geographic proximity (Fig. 11.11.3) gives us several groups of countries with similar average indicators for the indicators in this section.

It is to be expected that the average indicators for this section will produce clusters that reflect natural and climatic zones. The countries located in the most severe climate of the northern latitudes form a single cluster, together with Japan and South Korea. It is noteworthy that Russia is included in the same cluster with Canada, Australia, New Zealand, as well as Northern, Western and Central Europe.

We should also note those countries that fall out of clusters (Fig. 11.11.4), as well as the fact that smaller states are distributed among neighbouring clusters.

On the second cartogram, where geographic proximity carries the same weight as the indicator values, China, as well as India, Pakistan, Afghanistan, Iran and the countries of Central Asia and the north of the Arabian Peninsula (Syria, Iraq and Jordan), make up a one cluster. Vietnam, Laos, Myanmar, Cambodia, Thailand, Malaysia, North Korea, South Korea and Japan also differ significantly from each other in terms of the indicators for this section. However, geographic proximity allows them to be clustered into a single group, thus making these countries “weak” exceptions.

A large number of “weak” exceptions are found in South America. The countries of Central America and the Caribbean are divided into two clusters, although not in line with the mapping of clusters by geographic proximity. The first includes Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, and the islands of Cuba, the Dominican Republic and Jamaica. The neighbouring cluster is made up of the remaining Caribbean countries, Venezuela, Guyana and Suriname.

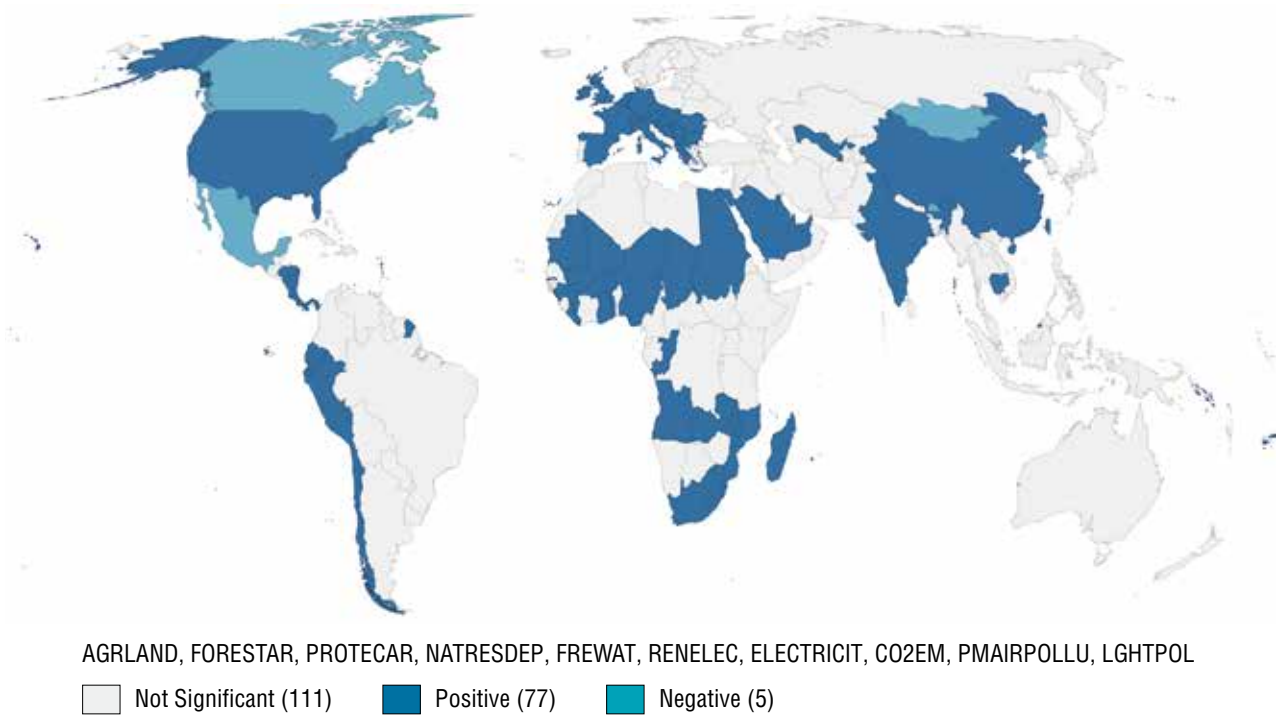


Fig. 11.11.1. "Ecology" section spatial autocorrelation cartogram for the geometric neighbourhood matrix

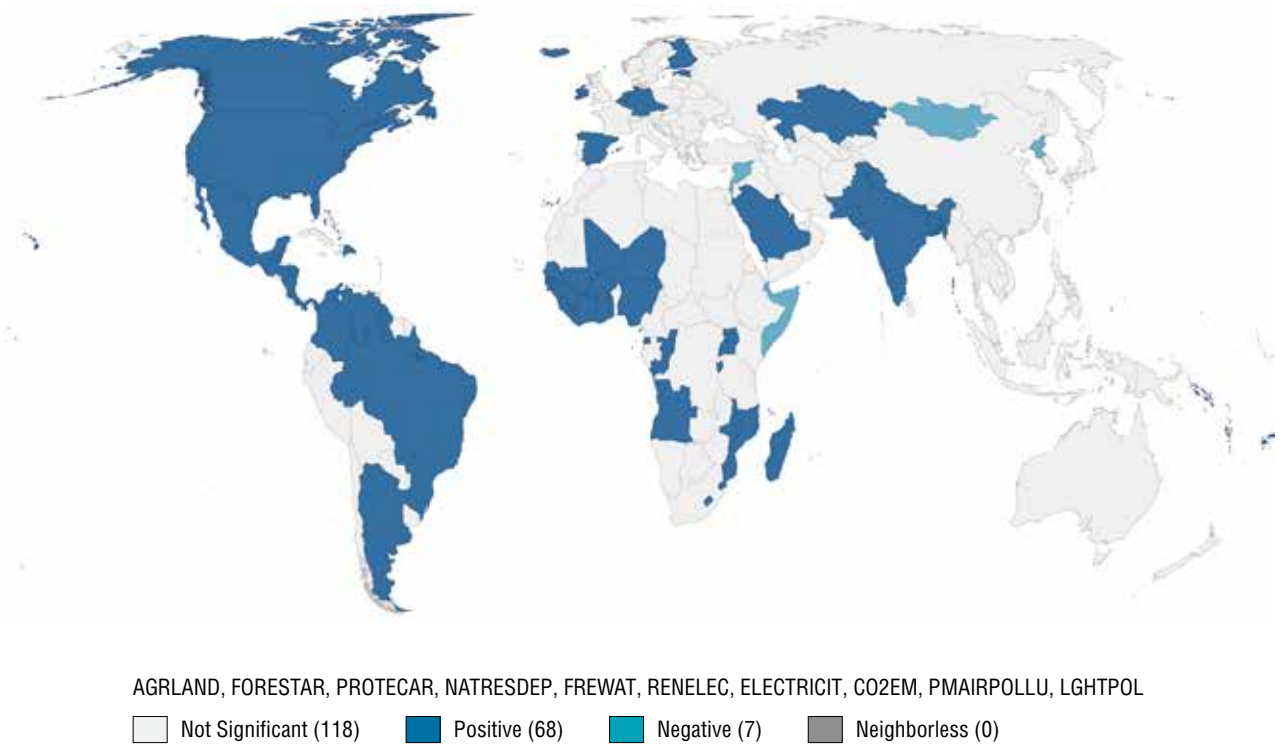


Fig. 11.11.2. Spatial autocorrelation cartogram for five indicators in the Ecology section for the geopolitical neighbourhood matrix

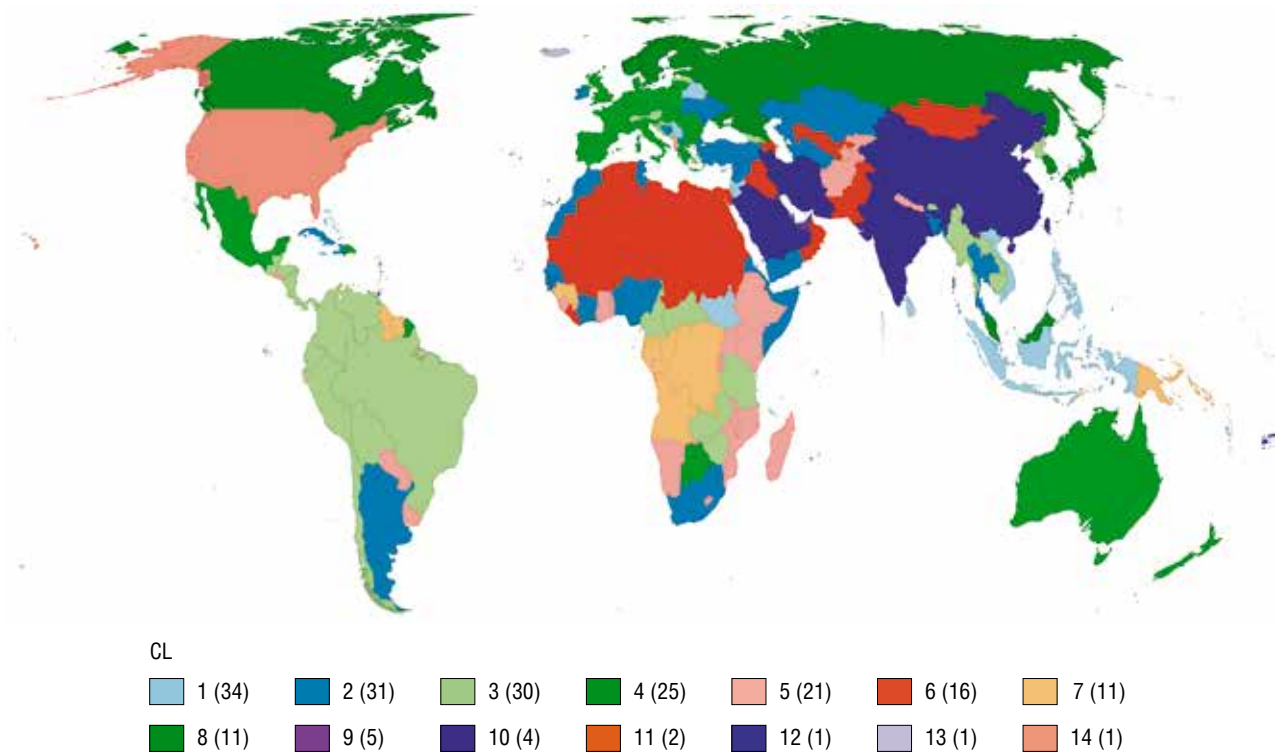


Fig. 11.11.3. Statistical clusters cartogram for the “Ecology” section indicators non-adjusted for geographic proximity

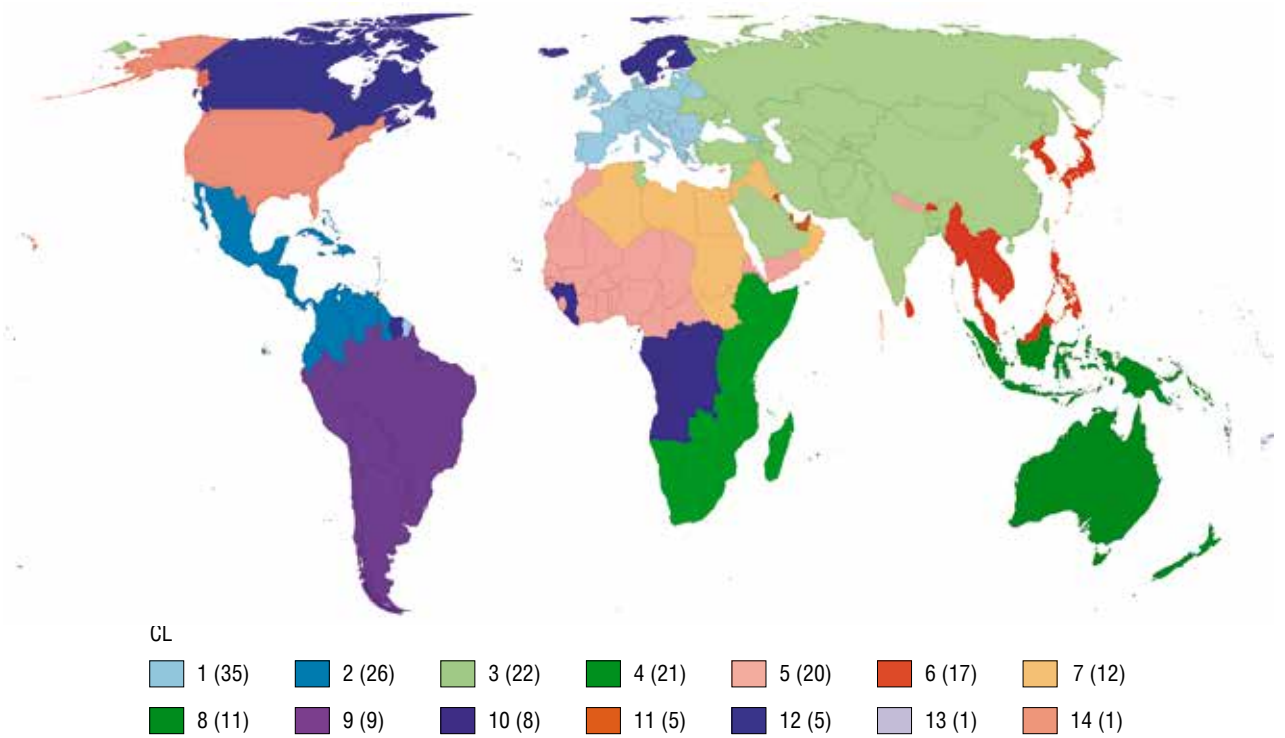


Fig. 11.11.4. Statistical clusters cartogram for the “Ecology” section indicators adjusted for geographic proximity

Southern Africa is another curious example of a “weak” exception. Despite the significant dissimilarity of the statistical indicators adjusted for geographic proximity, the countries of this sub-region fall into a single group.

Tunisia is a “strong” exception in Africa: it does not appear in any of the neighbouring clusters, and rather belongs to the large Asian cluster. The Central African cluster is made up of Sierra Leone, Guinea, Liberia and Ghana, which are also “strong” exceptions. Other exceptions include the former Soviet republics of Central Asia: they are adjacent to the Asian cluster, but given their geographic proximity, they are included in the same cluster with Russia and China.

Interestingly, almost all of Europe falls into the same cluster with Russia, Canada and Australia, and taking into account the geographical proximity, it stands out as one separate cluster, while Northern Europe falls into the same cluster with Canada.

The scatter plot of country values based on the results of multidimensional scaling of the entire group of ecology indicators (Fig. 11.11.5) is rather blurry. This is a result of the multidirectional nature of the parameters in this section, which is probably why the graph demonstrates such a high level of dispersion. That said, we should note that those countries that least resemble others in terms of their size, geography, economy and other indicators (including those relating to the environment) are mostly located in the “cloud” individually. This applies primarily to the largest countries in terms of area, such as the United States (point 1 in Fig. 11.11.5) and China (2). Note that Russia (3) is located near Canada (countries that are similar in terms of area and, to some degree, climate) and Australia (8).

At the same time, let us draw attention to the fact that, in terms of the group of environmental indicators, the countries of Europe are located rather close to one another, as well as to the centre of the graph (typical examples in Fig. 11.11.5 are the United Kingdom at point 4, and Italy at point 6). Almost exactly the same can be said about the majority of African countries, which are “grouped” on the left side of the graph (see, for example, Zimbabwe at point 5), as well as about the countries of Asia (see Azerbaijan at point 7 and Pakistan at point 10), and countries that are practically “imposed” on each other. As a rule, these are either physical neighbours, or countries located very close to each other geographically.

The multidirectional nature of the indicators in this section informed the decision to group the parameters into two types — resource availability and anthropogenic load — and test multidimensional scaling for one of the groups.

In terms of resource availability, which includes such indicators as forest areas, protected areas, fresh water, renewable energy, and availability of electricity, the scatter plot (Fig. 11.11.6) is mostly centralized and demonstrates a rather dense cluster of states, with two notable exceptions — the island nations of Iceland (point 4) and Fiji (point 5). Russia (point 3) is located in almost the very centre of the chart, while China (2) and the United States (1) are also located close to the other states. The countries of Africa are located on the left side of the graph (Sudan at point 6, with the other North African countries nearby), while the Western European states are located to the right (for example, Germany is at point 7). We can state that, as a rule, geographic neighbours in sub-regions are located extremely close to one another on this graph.

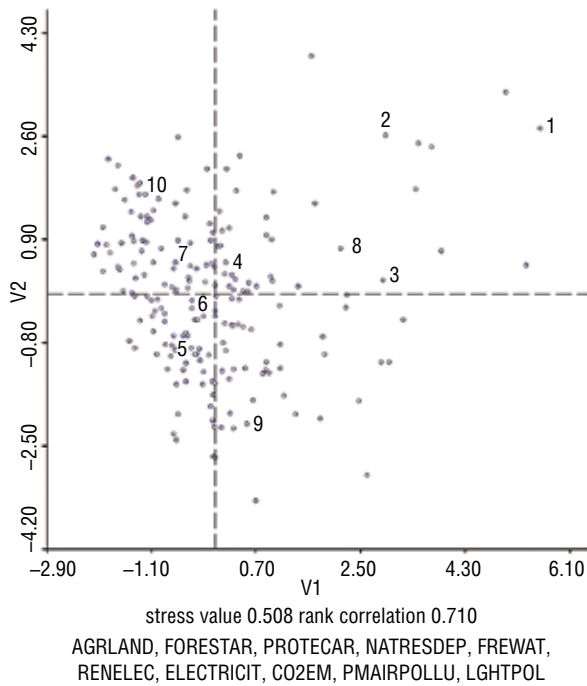


Fig. 11.11.5. Multidimensional scaling chart for the “Ecology” section indicators

1	United States
2	China
3	Russia
4	United Kingdom
5	Zimbabwe
6	Italy
7	Azerbaijan
8	Australia
9	Guyana
10	Pakistan

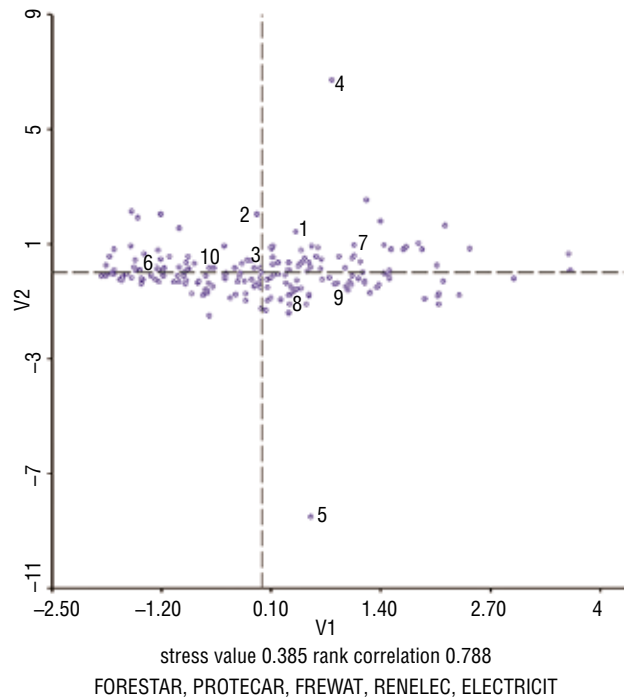


Fig. 11.11.6. Multidimensional scaling chart for the “Ecology” section indicators in the “Resource availability” sub-section

1	United States
2	China
3	Russia
4	Iceland
5	Fiji (outlier)
6	Sudan (near to Northern African countries)
7	Germany
8	Malaysia
9	Panama
10	Serbia

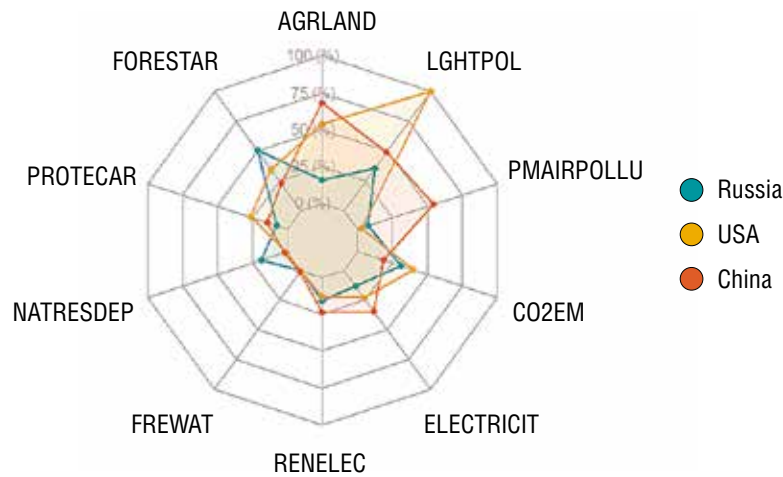


Fig. 11.11.7. Radar chart for the “Environment” section indicators

11.12. Spatial factor for the “Ecology” section indicators

Our analysis in this section of indicators that reflect the state of the environment allows us to assess the anthropogenic impact on various regions and thus identify relationships between the environmental situation and the geographic location of countries in relation to their neighbours, as well as to draw conclusions about the greater or lesser significance of geographic distribution compared to geopolitical distribution. The factors that influence the environmental situation can be divided into two groups: indicators that reflect human intervention in the environment as a result of economic activities (the share of agricultural land, the depletion of natural resources, the amount of CO₂ emissions per capita, particulate air pollution, light pollution); and indicators that determine the level of environmental resilience to the anthropogenic load exerted on it and give us an idea of the degree to which humankind has the resources necessary for a decent life and development (forest areas, protected areas, fresh water, the availability of electricity, renewable energy).

These groups of parameters can be considered both in aggregate, for a comprehensive analysis of the state of the environment, and separately, to compare the scale of the anthropogenic load on the environment and its resource potential.

The authors used spatial econometrics methods to perform a comparative analysis of Moran's I for all ten ecology indicators with two spatial neighbourhood matrices — geometric and geopolitical. In nine cases, the neighbourhood effect turned out to be more significant in absolute (“geometric”) space, where “neighbourhood” is considered according to the legal borders of countries and the territorial proximity of their capitals, than in relative geopolitical space, where “neighbourhood” is considered according to the degree of participation in political and economic integration associations.

The greatest influence of the neighbourhood effect in terms of both the geometric and geopolitical matrices is observed in the particulate air pollution indicator, where Moran's I is 0.68 for the geometric neighbourhood matrix and 0.546 for the geopolitical neighbourhood matrix. The results obtained indicate a spatial dependence on the level of pollution, which is natural given the fact that the highest scores are posted by countries where traditional industry is developing rapidly, waste treatment technologies are lagging, and the dirtiest fuels (coal, gasoline, diesel, and other petroleum products) are used. Most of these countries are located in Asia (India and Nepal) and Africa (Niger, Nigeria, Mali, Mauritania and other states in the west of the continent). Air pollution is also high in some oil-producing countries in the Middle East.

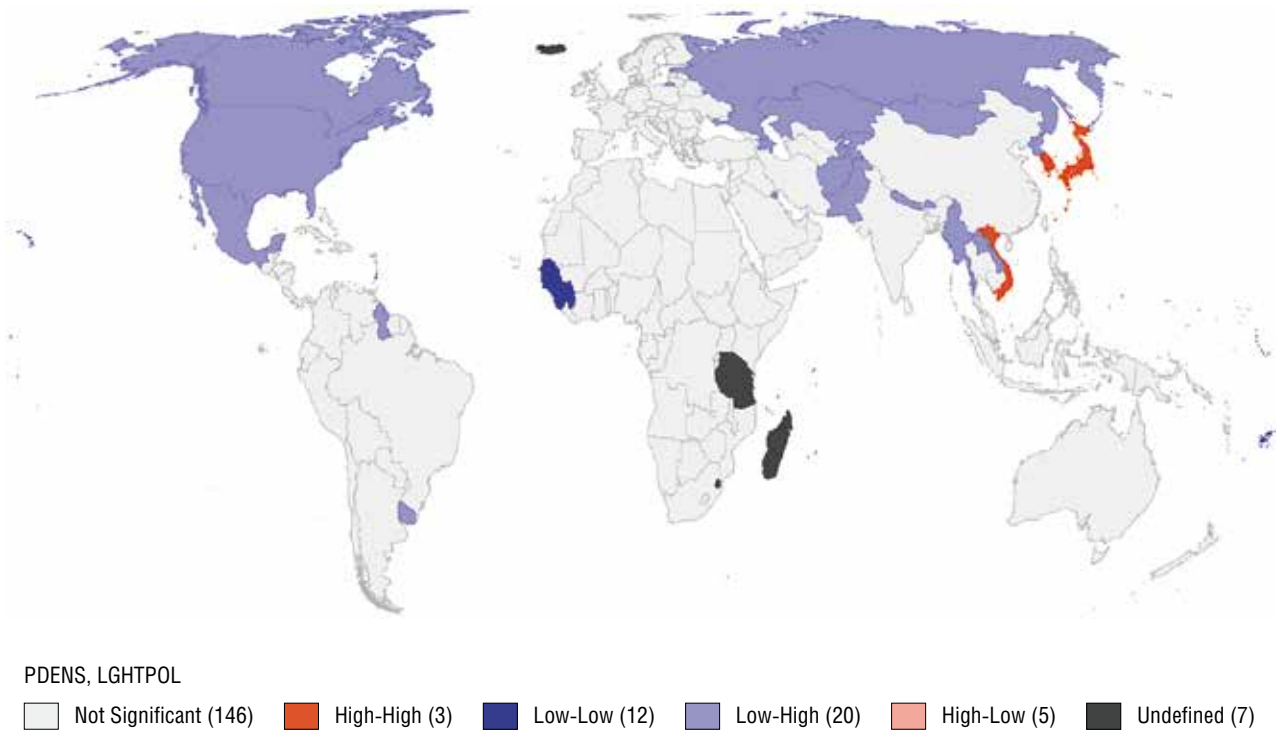


Fig. 11.12.1. Spatial autocorrelation cartogram for population density and light pollution by geometric neighbourhood matrix

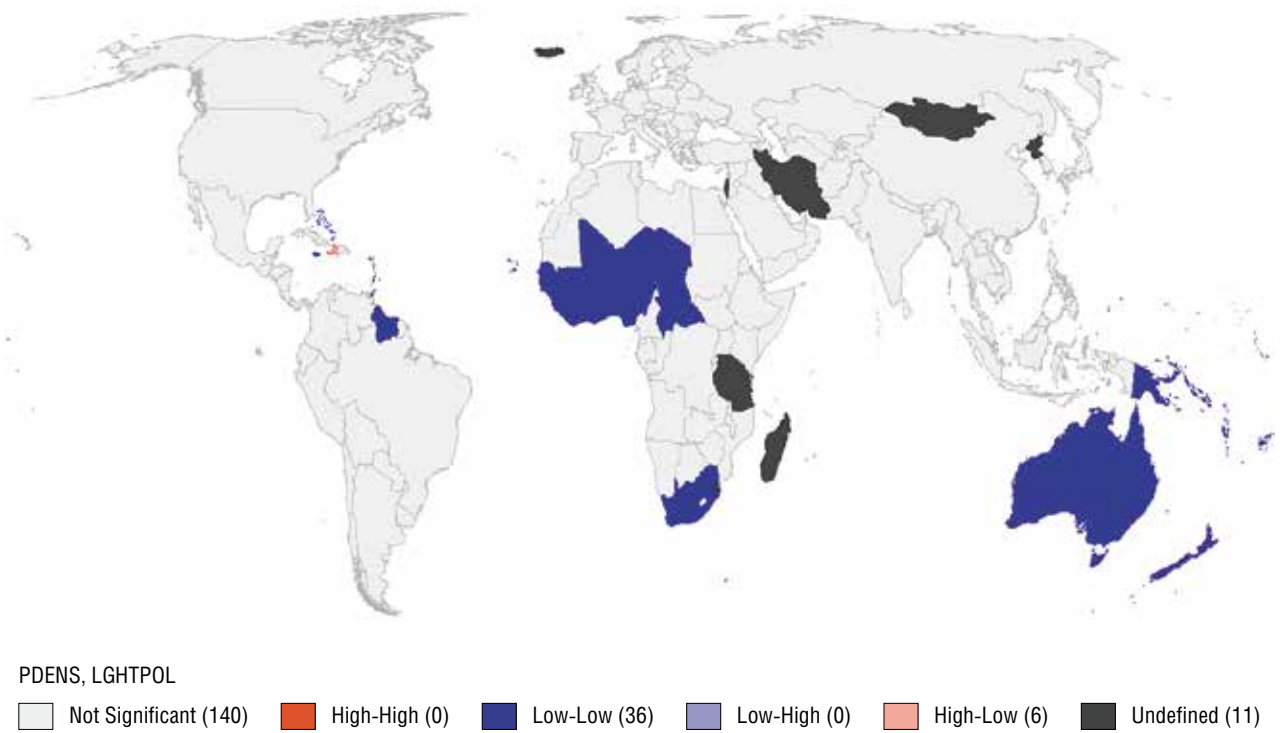


Fig. 11.12.2. Two-factor spatial autocorrelation cartogram for population density and light pollution by geopolitical neighbourhood matrix

The neighbourhood effect is also observed for such parameters as CO₂ emissions per capita, forest areas, and Availability of electricity (Moran's I of 0.456, 0.407 and 0.401, respectively).

A comparison of the two-factor analysis of the “Ecology” section with other sections of this atlas shows no statistically significant spatial effects between the environmental parameters and the other data. That said, the relationship between the indicators we have looked at in this section and those in the “Healthcare,” “Demography,” “Economics” and other sections is obvious (Fig. 11.12.1 and 11.12.2).

Our analysis of the geographic average led us to the conclusion that natural resources are being depleted faster in the developing countries of the Global South, since extensive farming requires a larger scale of human intervention in the natural environment and destroys the ecological balance to a greater degree. Conversely, the Global North suffers from high levels of CO₂ emissions and significant light pollution, a consequence of industrial development and urbanization.

In addition to the division of the world into the global South and the global North, we can also see a division into West, where light pollution is a bigger problem than CO₂ emissions, and East, where the opposite is true.

The inverse spatial cluster analysis non-adjusted for geographic proximity gave us clusters that reflect natural and climatic zones. When adjusted for geographic proximity, however, the influence of economic development on the formation of clusters can also be traced.

The significance of the environmental situation as a factor in human development cannot be understated, as it affects the quality of human potential as a whole. Identifying spatial dependencies for the indicators in this area will allow us to perform a comprehensive assessment of the global state of the environment and develop measures to reduce the anthropogenic load on it, as well as to minimize the consequences of human activity on the environment by building a solid resource and infrastructure basis for restoring valuable natural resources such as forests and fresh water, and transitioning to a low-carbon “green” economy and sustainable “clean” production practices (for example, the use of renewable energy sources).

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12

*Spatial cluster
analysis*

LOOK at the cartograms in Fig. 12.1 and Fig. 12.2. They reflect the division of the world into two groups, and, importantly, there is no trace of the former bipolar world order in the form of division into geopolitical blocs. Nor are the groups divided into East and West — geopolitical designations that have become popular among scholars in recent years and which have been roundly criticized as a somewhat arbitrary method of cutting the world in two. In his book *Orientalism*, for example, the Palestinian American researcher Edward Said, talking about the issue of distinguishing between the concepts of “East” and “Oriental,” draws the rather interesting conclusion that the latter was constructed by European scholarship. But does the convention of separating the world into East and West extend to other dichotomies?

The cartograms demonstrate the division of the world into the Global North and the Global South — an economic, rather than a cultural, social or political dichotomy. The expert community continues to argue about the role of geography in the economic development of countries. The difference is that, in the past, discussions focused on the concept of geographical determinism, and the attribute understanding of territoriality prevailed in the field of political geography, while today the concepts of the “spatial factor” and “institutional choice” are the subject of debate. Daron Acemoglu and Simon Johnson argue that the role of geography in explaining cross-border economic development patterns manifests itself primarily, even exclusively, through the choice of institutions, with almost no direct impact of geography on income. Jeffrey Sachs points out that the choice of a given path of influence is a direct result of the spatial factor that affected the institutional choice in the past, and most likely today as well. At the same time, the discussion, as we can see, revolves around the role of the spatial factor, and not its influence as such.

The North–South divide continues to be a fundamental dimension of global dynamics today. We should not look at this dichotomy strictly in geographic terms, of course, if only because many countries of the “Global South” are actually located in the Northern Hemisphere, as we can see on Cartogram 12.1. That notwithstanding, the geographical component is important here.

Australia and New Zealand do not appear in the Global South cluster (Fig. 12.2). This is because, despite being on the geographical periphery, these countries play an important role in the global economy. They are in many ways united by their status as former British possessions, which affected the nature of their economic and political development as part of the British model of colonial capitalism. New Zealand is a developed industrial state and ranks highly in many economic ratings (first on the Corruption Perceptions Index, first in the Ease of Doing Business ranking, 23rd in the World Competitiveness Ranking, and a solid 16th on the Human Development Index). Australia is a leader in its region, its GDP per capita is slightly higher than that of the United Kingdom, Germany and France (by purchasing power parity). In 2011, a record number of Australian cities made it into The Economist’s Top 10 most liveable

cities in the world: Melbourne (1st), Sydney (6th), Perth (8th) and Adelaide (9th). What is more, like New Zealand, the country tops the rankings in economic development. What we thus have is a historical region whose countries are united by a common political structure and culture, and by joint development within the framework of the British Commonwealth. And while geographically Australia and New Zealand belong to Oceania, they have different economic structures and represent a different cultural group. Malaysia and Brunei also belong to the Global North. Malaysia has a common past with the Commonwealth of Australia and New Zealand: it had been a British colony until 1957, when it gained independence. A similar situation existed in Brunei, which was a British protectorate until 1984. It can be argued that the influence of Great Britain determined the development of these countries and their subsequent entry into the cluster of the Global North.

We will discuss the formation of clusters in the Global North and the Global South in Latin America separately, since the k-medians analysis with and without centroids gives different results. The situation with French Guiana is obvious — it is an overseas department of France, meaning that it is an integral part of France as a vector object on the cartogram. Far more interesting are the reasons why Brazil, Argentina, Uruguay and Chile are included in the Global North.

The physical and geographic features of South America will not provide an answer to this question. Although the parts identified by researchers — the Eastern part beyond the Andes and the Andean West — have fundamental differences in terms of their genesis, which has a significant impact on the development of the countries that make up these regions. The Andean countries are similar in many ways, a consequence of the fact that the Inca Empire was located on these territories (the historical interpretation of these regions often invokes a lost spatial identity). What is more, the countries of the Andean West are part of the Andean Community — a union of countries that promotes the development of member states through integration, socioeconomic cooperation, accelerated economic growth and employment, and creating a common Latin American market.

At the same time, these countries are also full members of MERCOSUR, and are the political and economic leaders of the continent, among the top 5 countries in terms of GDP per capita: Chile (USD 14,510), Argentina (USD 14,413), Uruguay (USD 13,294), and Brazil (USD 10,325). The only full member of MERCOSUR to not make it into the cluster of the Global North is Paraguay, which can be explained by the Paraguayan War, which claimed the lives of 70% of the country's population, crippling its development for decades. The consequences of the events have still not been fully overcome.

Dividing the world into four clusters gives us even more interesting results. The cartogram with centroids (Fig. 12.4) produces the following clusters:

1. United States, Canada, Europe, the countries of Northern Africa, the Middle East, the CIS, China, Japan and South Korea.
2. The countries of Central and Southern Africa, the countries of the southern part of the Arabian Peninsula, Pakistan and Afghanistan.
3. Latin America.
4. Oceania, Southeast Asia, the countries of the Indian subcontinent and Indochina.

The differences in the clusters on the two cartograms are more significant this time, with some countries even appearing in different groups. Relative stability can be observed with the countries of Latin America, as they appear in the same cluster on both cartograms.

The main difference is that the spatial factor cartogram (Fig. 12.4) consolidates Latin America as a separate cluster, while in Fig. 12.3, they are grouped together with Northern Africa, Southern Africa, Asia, Indochina and the countries of Eastern Europe. Let us take a closer look at the emerging deviant cases in Latin America. These include the following countries:

1. The Republic of Haiti.
2. Belize.
3. Suriname.

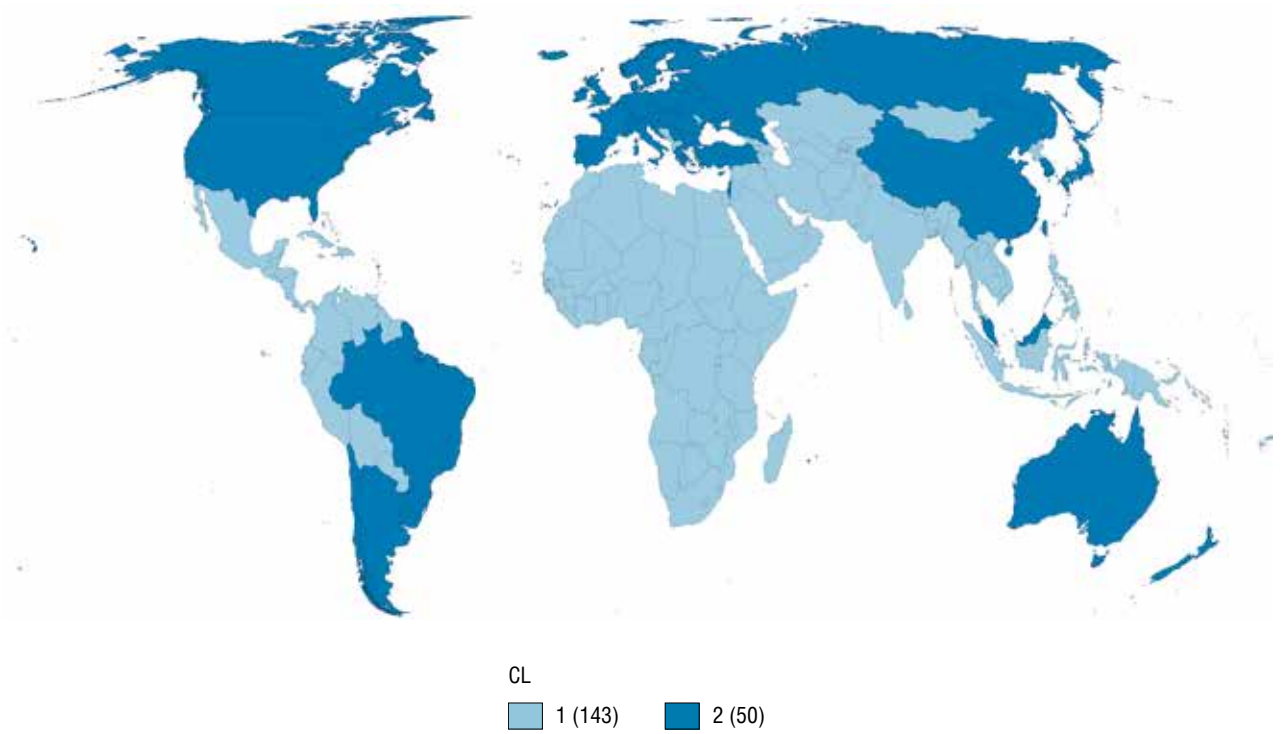


Fig. 12.1. Two k-median clusters without centroids

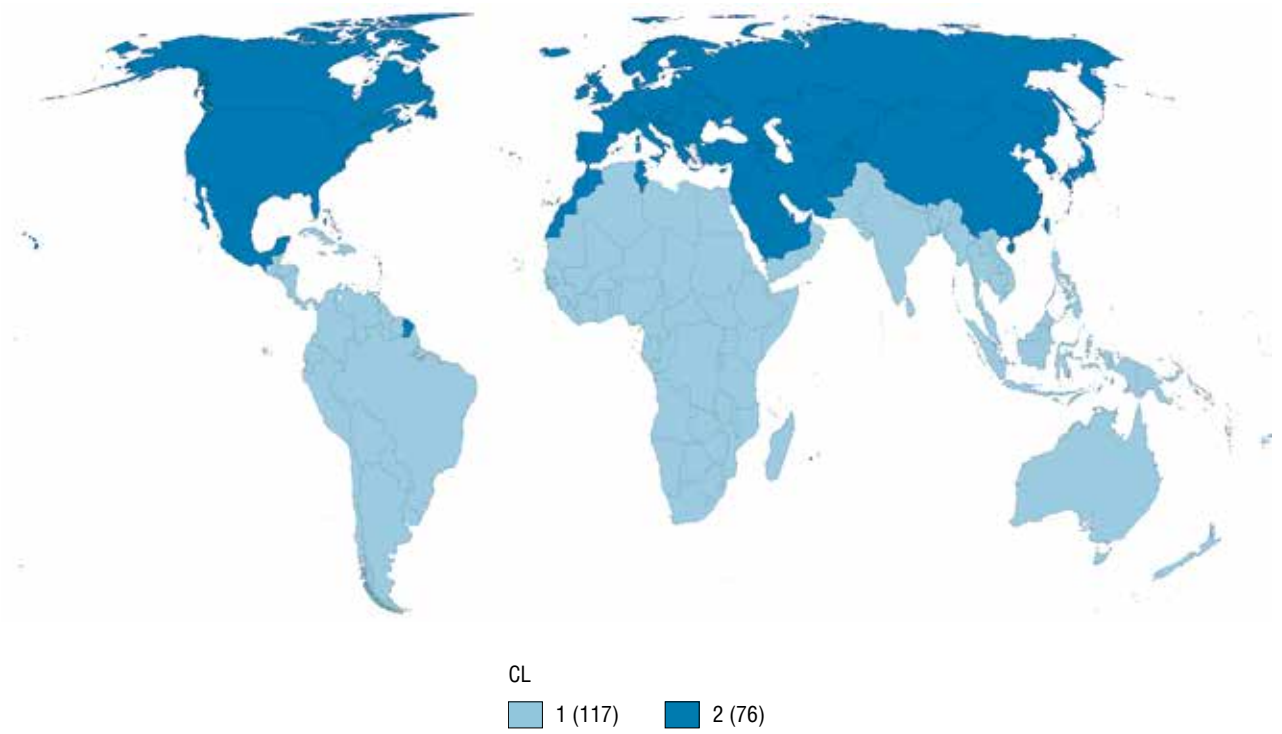


Fig. 12.2. Two k-median clusters with centroids

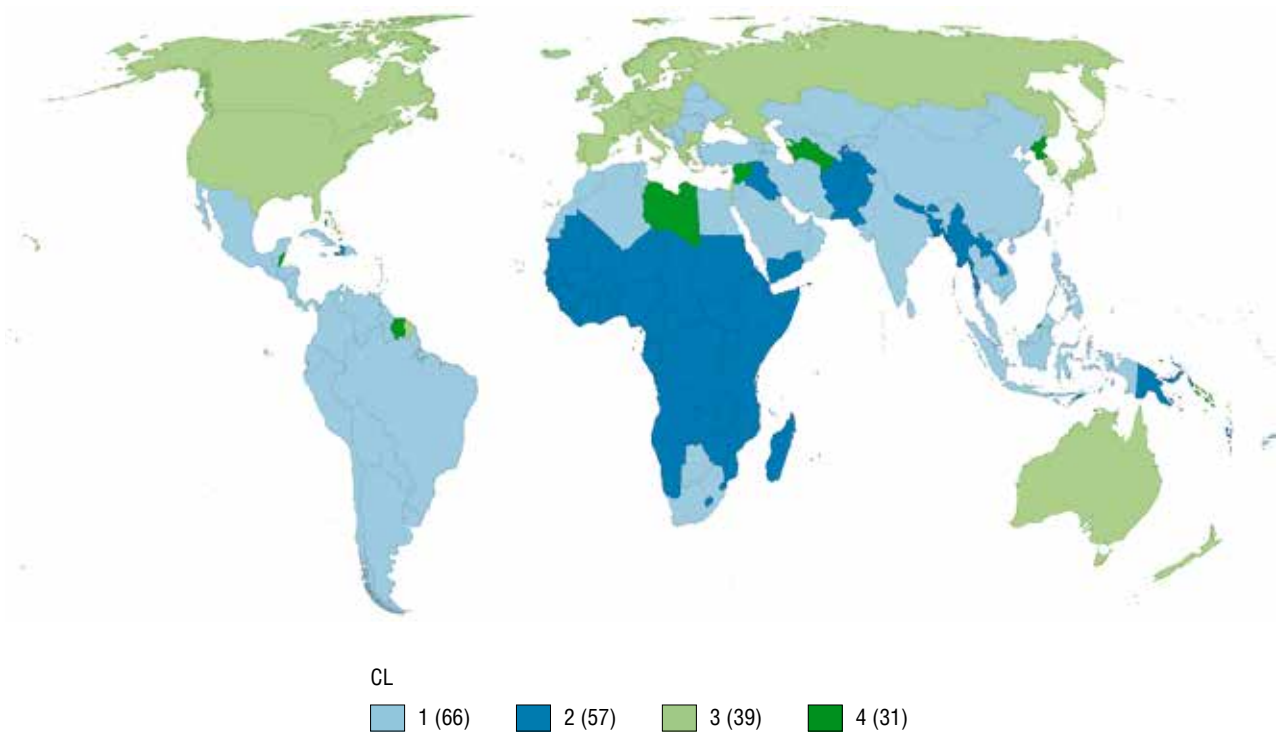


Fig. 12.3. Two k-median clusters without centroids

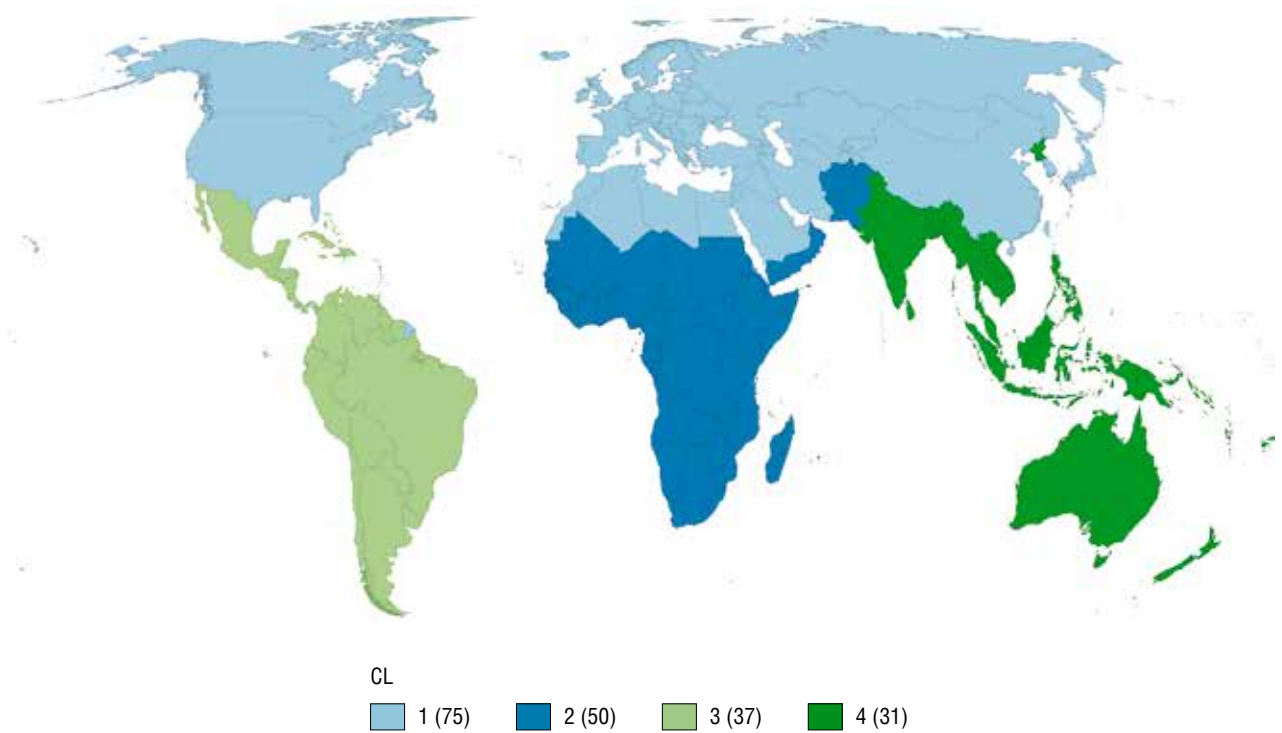


Fig. 12.4. Two k-medians cluster with centroids

These are underdeveloped agrarian countries, and they are far behind other polities in the region in terms of economic development. Suriname and Belize fall into the cluster that includes Libya, Syria and Turkmenistan. This group of countries can be defined as exporters of natural resources (oil, gas, bauxite, etc.) with an underdeveloped social sector, a poor level of digitalization, and social instability (especially Syria and Libya). This is why the oil exporters of the Arabian Peninsula were not included in this group.

The formation of clusters in Africa is interesting. Sub-Saharan Africa falls within a common cluster on both cartograms. These countries are predominantly weak agrarian economies that exhibit rapid population growth that even pandemics cannot stop. The average birth rate in these countries is as high as four to five children per family, as per the total fertility rate. This, coupled with widespread poverty, has led to a high level of conflictogenity and significant political and social instability in the region. Southern Africa (South Africa and Botswana) falls into the cluster that includes Latin America and Asia, regions that are marked by economic success and positive social development. In Botswana, for example, the main economic activity was animal husbandry until 1970, after which the country became a major exporter of diamonds and other minerals. The country's GDP growth reached 9% in the early 2000s. South Africa is also an important exporter of minerals, and the most developed country in Africa. Its GDP for 2015 was \$313 billion according to the IMF (33rd in the world), and \$350 billion according to World Bank statistics (making it the 32nd biggest economy in the world). GDP growth was recorded at 5% in 2015, compared to 3% in 2008.

Increasing the number of clusters to five places a number of countries into separate, isolated groups, while the general outlines of the groups from the previous cartograms are preserved. K-median cluster analysis with centroids gives us the following groups of countries:

1. Sub-Saharan Africa.
2. The developed countries of the North (the United States, Canada, the European Union, Ukraine, Russia).
3. The countries of Asia, The Indian subcontinent and Northern Africa.
4. Southeast Asia and Oceania.

A comparison of the four-and five-cluster cartograms shows that Suriname has moved to a different cluster: it now belongs to the group of countries that includes Asia, Indochina and Northern Africa, which is a result of the country being more dissimilar to its former cluster "colleagues" and demonstrates better economic dynamics. The most noticeable boundary changes are found in the Libya — Saudi Arabia — Oman cluster (Fig. 12.5 and Fig. 12.6). On the previous cartograms, these countries belonged to other groups, and it is interesting to discover which indicators could affect their isolation most strongly now. It is possible that the clustering is a result of the economic dependence of these countries on oil exports. For example, 75% of Saudi Arabia's budget revenues and 90% of its GDP is made up of oil exports, and 49% of Oman's GDP comes from the extraction and processing of oil. Libya has a similar economic structure, with half of its GDP coming from hydrocarbons. All these countries have poorly developed agriculture, a result of the unfavourable conditions for farming, meaning that most food is imported. These countries also post similar figures for the immigration indicator. Libya is home to a large number of refugees and immigrants from Central Africa, another factor that increases the risk of conflict in the country. Saudi Arabia and Oman, on the other hand, have high levels of labour immigration. As of 2019, immigrants make up 38.3% of the total population of Saudi Arabia, and 46% of the total population of Oman.

Six clusters led to the formation of new regions — Central and Southern Africa (Fig. 12.8). No other changes or differences are observed. A comparison of the formation of clusters with and without centroids will thus be carried out for the following groups:

1. The United States, Canada, Europe, Russia.
2. Central Asia, central part of the Indian subcontinent, the Middle East, North Africa.
3. Latin America.
4. Central and Eastern Africa.
5. Southeast Asia and Oceania.
6. Southern Africa.

The cluster that included Libya, Saudi Arabia and Oman has disappeared, with a new group being formed instead — a cluster of Caribbean islands that is barely visible on the cartogram (Fig. 12.7). The countries (Saint Vincent and the Grenadines, Martinique, Dominica and Saint Lucia) have small populations, and their economies are based on agriculture and tourism. Latin American countries retain their place in a single group, with the exception of Suriname, which has moved into the same cluster as Bhutan. Bhutan is an agrarian country, with much of its territory being made up of nature reserves, a fact that complicates the process of industrialization but improves the country's environmental performance. There are practically no similarities between Suriname and Oman, and their positioning in the same cluster can be explained by averaging the indicators of the countries.

Major changes are observed in Africa. Two new clusters have emerged: Central Africa and Eastern Africa, which previously formed a single group. This division is associated with the systemic and complex differences between the countries in these clusters in terms of their economies, social wellbeing and political stability. The main type of economic activity in the countries of Central and Eastern Africa is farming. A significant part of the population lives in poverty and experiences food shortages. Droughts make the agricultural sector unstable, and the poorly developed irrigation and cultivation technologies make the problem impossible to solve. The weak economy leads to social problems and a high level of conflictogenity.

Southern Africa differs from the other parts of the continent in that it has an advanced mining industry, and its secondary and tertiary sectors are relatively developed too. Many of the countries in the region also have strong infrastructures. This cluster is similar to the borders of the Southern African Development Community (SADC) (Fig. 12.7). With that said, only South Africa and Botswana stand out as a separate group on the cluster cartogram without centroids. As we noted earlier, South Africa and Botswana are the most developed countries on the continent.

The first cartogram is interesting for the fact that Latin America is divided into three clusters, an Eastern European cluster that includes Russia has appeared, and Indochina has detached itself from Oceania (Fig. 12.9). The following clusters can be identified for the cartogram that is adjusted for the spatial factor:

1. The United States, Canada, Europe, Russia.
2. Central Asia, the Middle East, Northern Africa.
3. Central and Eastern Africa.
4. South America, excluding its northernmost part.
5. Southern Africa.
6. The Indian subcontinent and Indochina.
7. Melanesia

The most interesting changes this time have taken place in Europe. Western and Central Europe, for example (excluding Portugal) remain in the cluster that includes the United States, Canada and Australia, while Eastern Europe has either joined Russia or, in the case of Ukraine and Belarus, moved into the cluster of Central Asian and South American countries (Fig. 12.10). This division can be easily explained: Eastern Europe is weaker economically, and lags behind its Western European counterparts in terms of equality and ecology (this kind of development is referred to as “two-speed development” in the European Union). Ukraine and Russia are not in this cluster due to the unstable domestic environment in these countries: Ukraine in crisis following the events of 2014, and Belarus is being torn apart by internal contradictions that are made all the worse by its surplus economy.

The Arabian Peninsula, specifically Saudi Arabia and Oman, is particularly interesting. These countries had previously been part of a common cluster, but they have separated into a group of their own on these cartograms. As we noted earlier, Saudi Arabia and Oman are oil-exporting countries with a high proportion of labour migrants. The similarities do not end there, however. Both countries have well-developed education systems and a high level of investment, and both score low on equality indicators (due to the Islamic law currently in place). They also have similar political systems, and face almost identical problems.

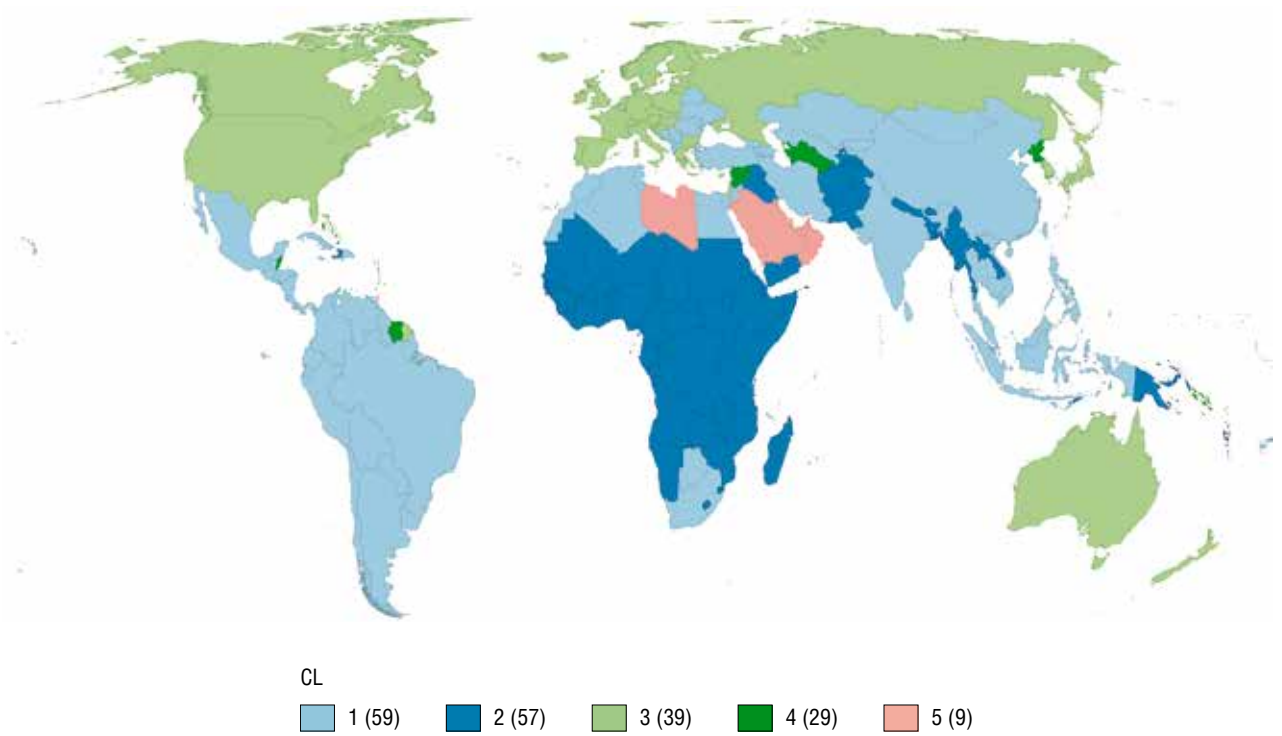


Fig. 12.5. Five k-median clusters without centroids

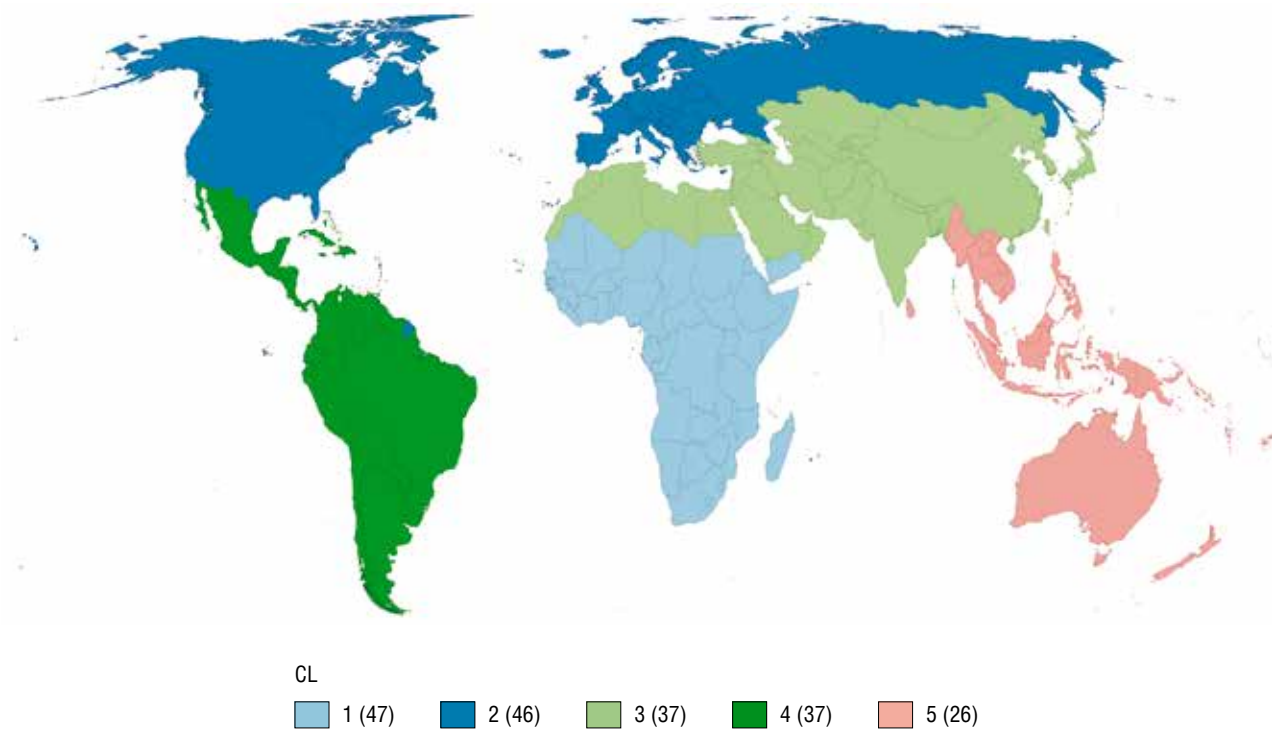


Fig. 12.6. Five k-median clusters with centroids

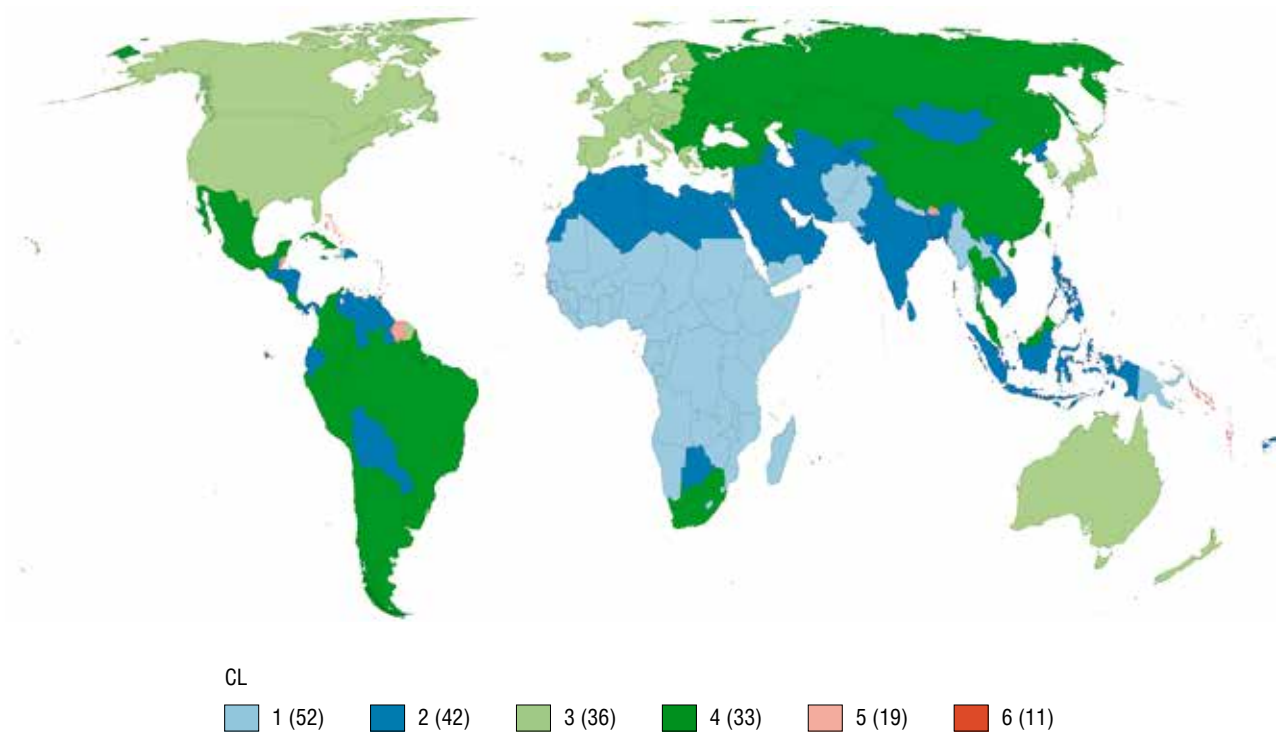


Fig. 12.7. Six k-median clusters without centroids

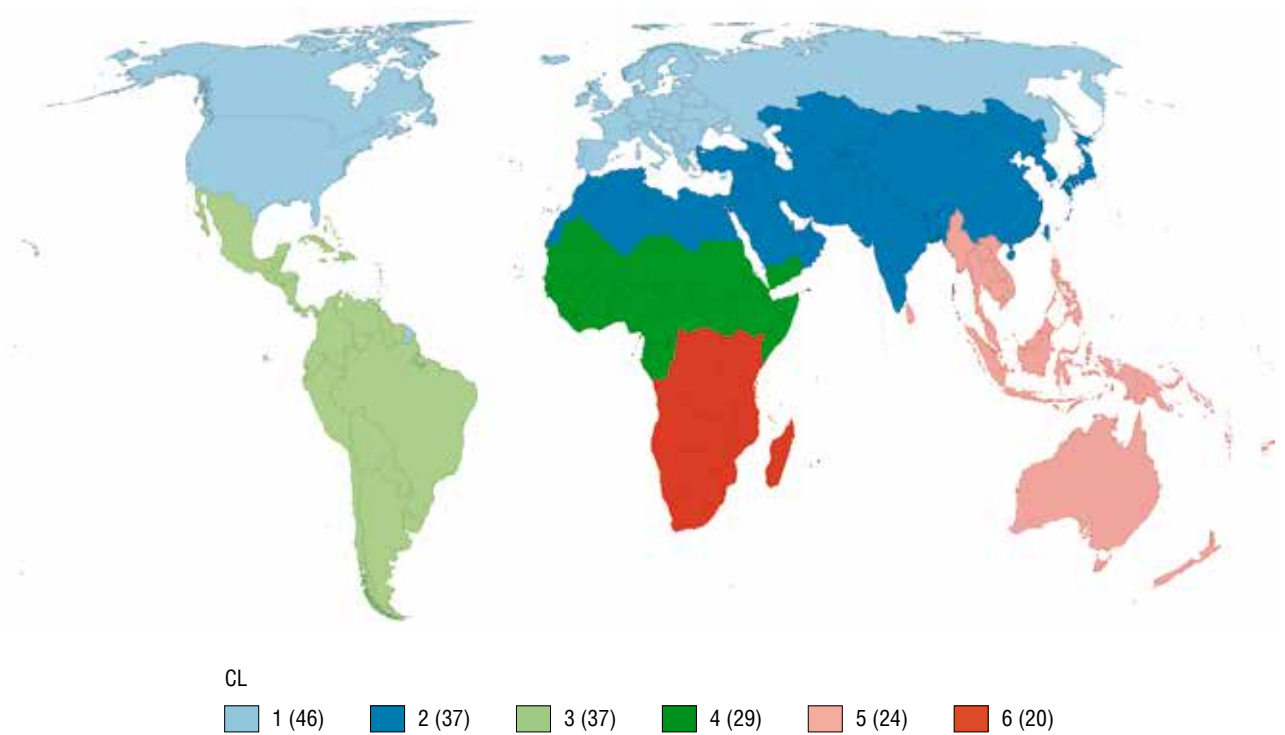


Fig. 12.8. Six k-median clusters with centroids

The nine-cluster cartograms rocked the inviolability of Latin America even more. Mexico, as well as the countries of the Isthmus of Panama and the northern part of South America formed a single grouping, alongside Chile (Fig. 12.12). The countries of North Africa, the Arabian Peninsula and the Middle East also form a cluster. The cluster of Oceania and Indochina has been decoupled, with the countries of Indochina and Indonesia moving into the cluster that includes China, South Korea, Japan and the polities of the Indian subcontinent. The following clusters are thus formed when centroids are taken into account:

1. The United States, Canada, Europe, Russia.
2. Central Asia, the countries of the Indian subcontinent, the Middle East, Northern Africa.
3. Southern Africa, minus its northern part.
4. Central and Eastern Africa.
5. Southeast Asia and Oceania.
6. Southern Africa.
7. The CIS and Eastern Europe.
8. Mexico, the countries of the Isthmus of Panama, the northern part of South America.
9. Australia, New Zealand, Micronesia.

Latin America has lost its homogeneity and is now part of two separate clusters. Ecuador, Peru, Bolivia, Paraguay, Venezuela, Guyana, Guatemala, El Salvador and Honduras, for example, have moved into a variegated group of countries that are spaced relatively far apart and include Namibia, Ghana and Botswana in Africa, as well as India, Nepal and Indonesia. This is not due to economic lag, but rather to education and health indicators (Fig. 12.11).

The nine-cluster cartograms preserve the division of Europe and separation of Saudi Arabia and Oman that occurred in the eight-cluster cartograms. A separate cluster on the cartogram that does not account for the spatial factor is made up of the countries of North Africa and the Middle East (excluding Israel). These countries have a number of similar economic and political problems: suboptimal conditions for farming, and low levels of industrialization. In some countries, the situation is exacerbated by political instability (Syria, Libya, Afghanistan and Iraq).

Increasing the number of clusters to 12 brings about visible changes in the formation of country groups, both adjusted and non-adjusted for the spatial factor (Fig. 12.13 and 12.14). The South American cluster (minus its northern part) remains, with the northern part being split into two groups: Venezuela, Guyana and Suriname make up one cluster, while Colombia has joined the countries of the Isthmus of Panama, which has in turn merged with Mexico and the United States. Africa has split into even more clusters: North Africa has joined the Middle East; Central and Eastern Africa have broken into two clusters; and South Africa remains isolated from the rest of the continent, but in a group with countries located in other regions. Eastern Europe has formed a separate cluster with the Balkan countries. The following spatial clusters can thus be identified:

1. Canada, Western Europe.
2. Eastern Europe, the Balkan countries.
3. Central and Western Africa.
4. Southern Africa.
5. The countries of the Indian subcontinent, Indochina, China, South Korea, Japan.
6. Northern Africa, the Middle East.
7. Venezuela, Guyana, Suriname.
8. Colombia, Mexico, the countries of the Isthmus of Panama, the United States.
9. Melanesia.
10. The CIS, Iran, Pakistan, Afghanistan.
11. The countries of South America, minus its northern part.
12. Ethiopia, Eritrea, Somalia, Yemen.

Calculating the 12 clusters without centroids saw the Scandinavian countries and New Zealand form a separate group. The Scandinavian countries are characterized by the focus on increasing individual autonomy, promoting social mobility, ensuring basic human rights, and ensuring economic stability. New Zealand, which does not follow the Scandinavian model, has a high GDP, as well as high levels of social mobility and environmental friendliness.

A number of interesting changes in the boundaries of clusters are noticeable in Europe, with Serbia, Bosnia and Herzegovina, Kosovo, Montenegro and Macedonia joining the group of Ukraine, Belarus and Moldova. Croatia is not in the same group as the countries of the former Yugoslavia. There is an historical explanation for this — Croatia has always gravitated towards Europe, and it was among the first countries of the former Yugoslavia to join the European Union after achieving independence. This orientation towards Europe is largely due to religion: Croats are Catholics, whereas Serbs are Orthodox Christians. Croatia receives substantial support from the European Union and the International Monetary Fund to help restore its economy. But Serbia suffered more as a result of the territorial conflicts in Yugoslavia following the bombing of Belgrade and other key industrial centres, and the country's economic potential was hampered significantly by UN sanctions. On the whole, the countries that make up this cluster are crisis states that have serious economic and social problems.

The main changes we see when increasing the number of clusters affected the cartogram that does not account for the spatial factor. However, we will first describe the changes in the cartogram with centroids. Here, we see the countries of Indochina and Indonesia form a separate cluster. Oman and Saudi Arabia continue to exist in a cluster that is independent of the Middle East. The United States has unexpectedly returned to the European cluster, while Venezuela has moved to the cluster that includes the countries of the northern part of Latin America and the countries of the Isthmus of Panama. The following clusters can thus be distinguished, with account for centroids (Fig. 12.15):

1. Eastern and Southern Europe.
2. Southern Africa (plus part of Central and Eastern Africa).
3. Western Africa.
4. Melanesia.
5. The United States, Canada, Western Europe.
6. The countries of the northern part of South America.
7. Suriname, Guyana, Trinidad and Tobago.
8. The MENA countries.
9. The countries of Indochina and Indonesia.
10. The CIS countries, Pakistan, Afghanistan.
11. The countries of the Indian subcontinent, China, the Korean Peninsula, Japan.
12. South America, minus the northern part.
13. The countries of Eastern Africa.
14. Mexico, the countries of the Isthmus of Panama.

The cartogram that has not been adjusted for the spatial factor (Fig. 12.16) shows that Chile and Argentina have shifted to the cluster that includes the countries of Eastern Europe, Russia and the CIS. Chile and Argentina have stronger economies than their neighbours (they are rapidly developing and actively industrializing countries), and many of the social problems that are typical of Brazil, for example, are not as serious for them, so their presence in this cluster is not surprising.

The cluster of CIS states and some Balkan countries is interesting for the reasons for its formation. On the one hand, these are developing countries (which explains why Chile and Argentina are in the same group). Plus, they are close culturally. The countries of the former Yugoslavia are mostly populated by South Slavs who have similar cultures and traditions. Russian culture has a significant influence on the CIS, if only because of the sizable Russian-speaking population in the region. This group of countries is defined by the manner in which it emerged — following the collapse of a larger polity.

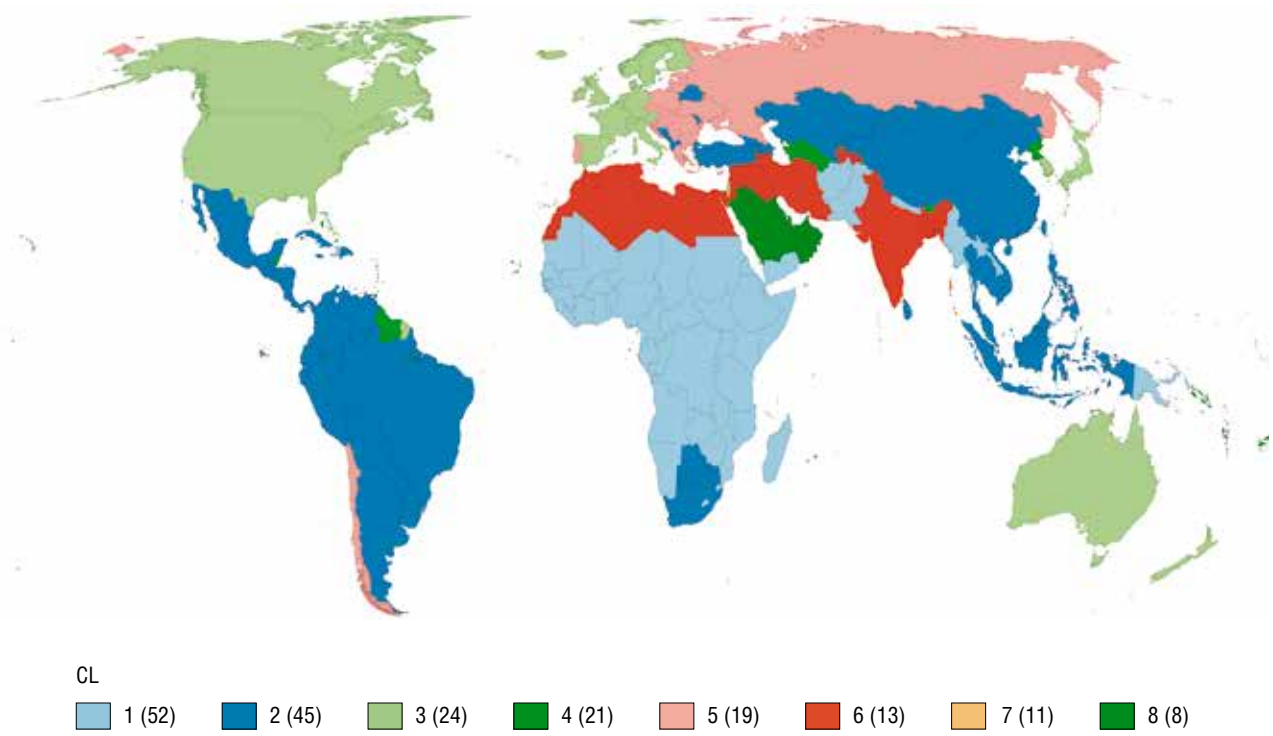


Fig. 12.9. Eight k-median clusters without centroids

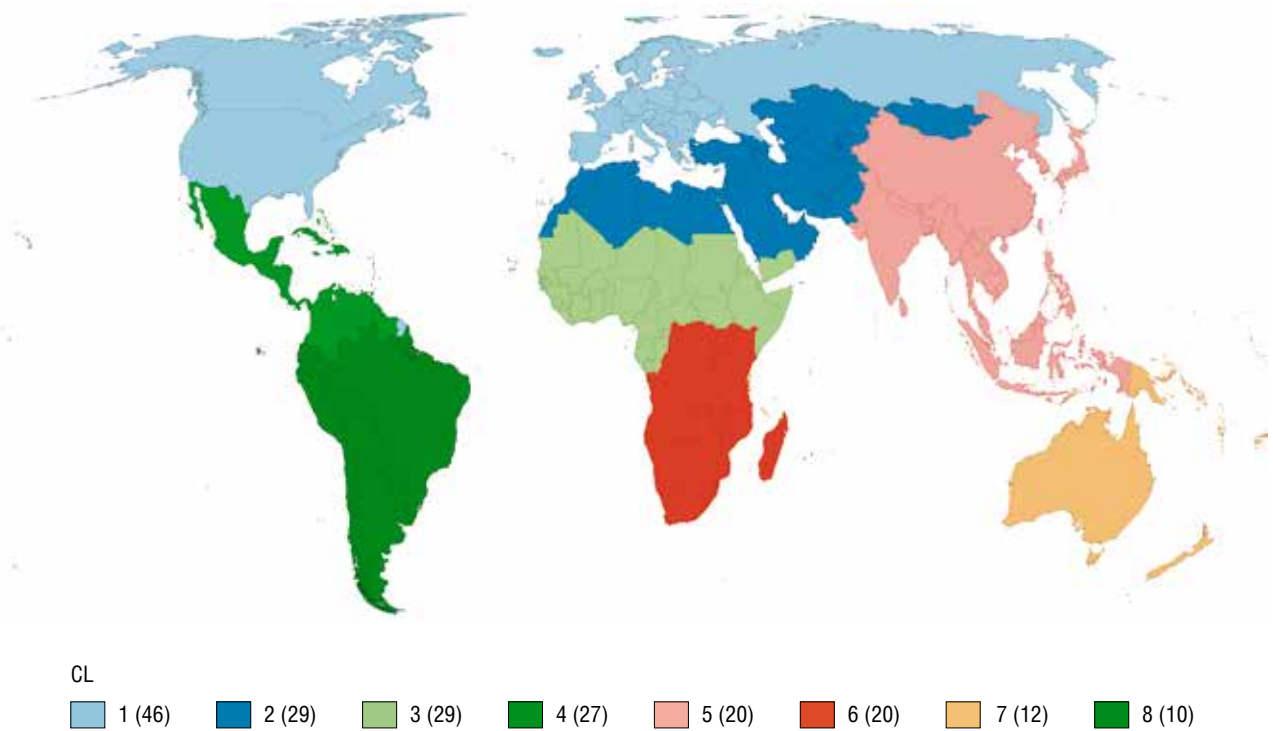


Fig. 12.10. Eight k-median clusters with centroids

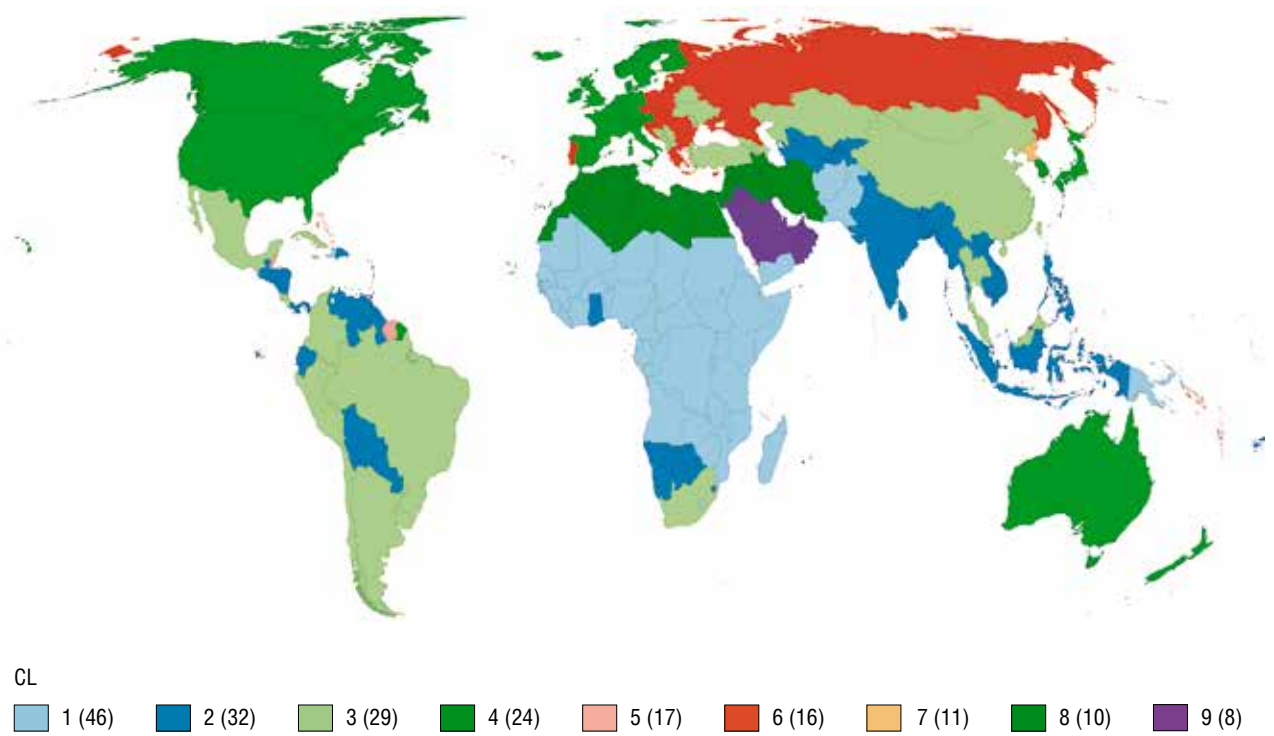


Fig. 12.11. Nine k-median clusters without centroids

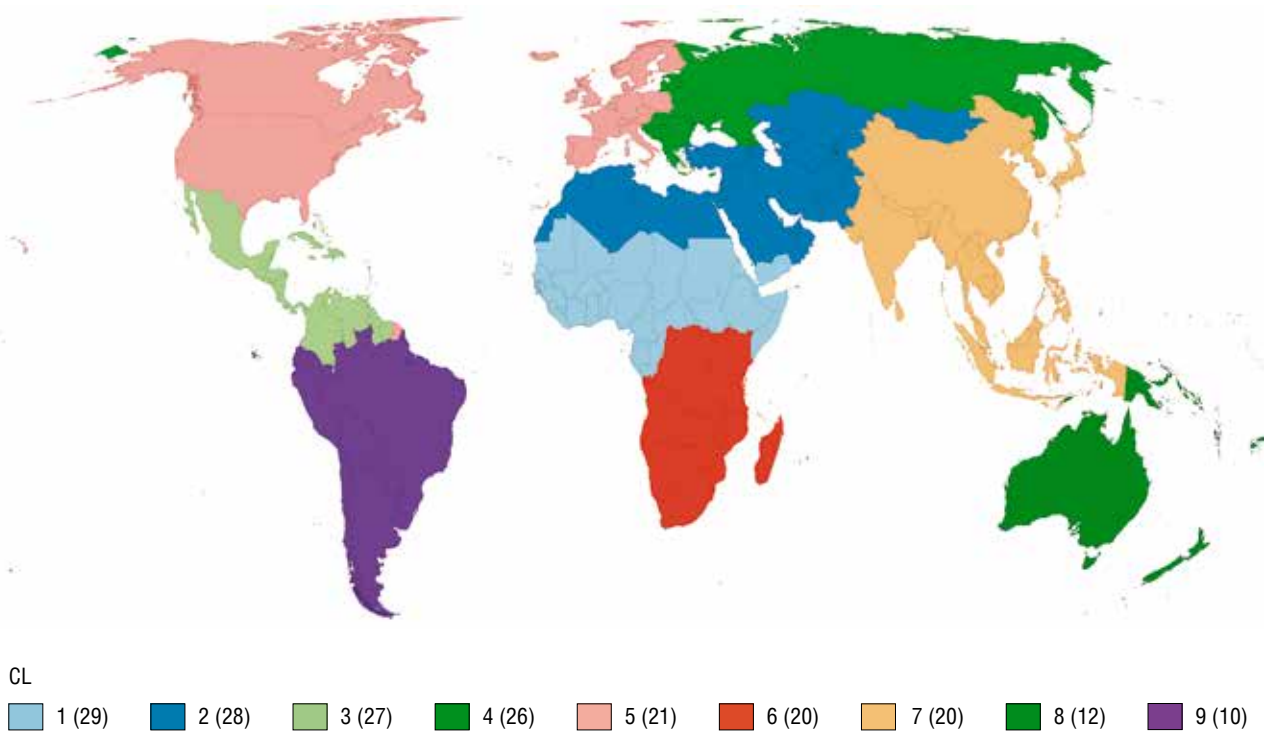


Fig. 12.12. Nine k-median clusters with centroids

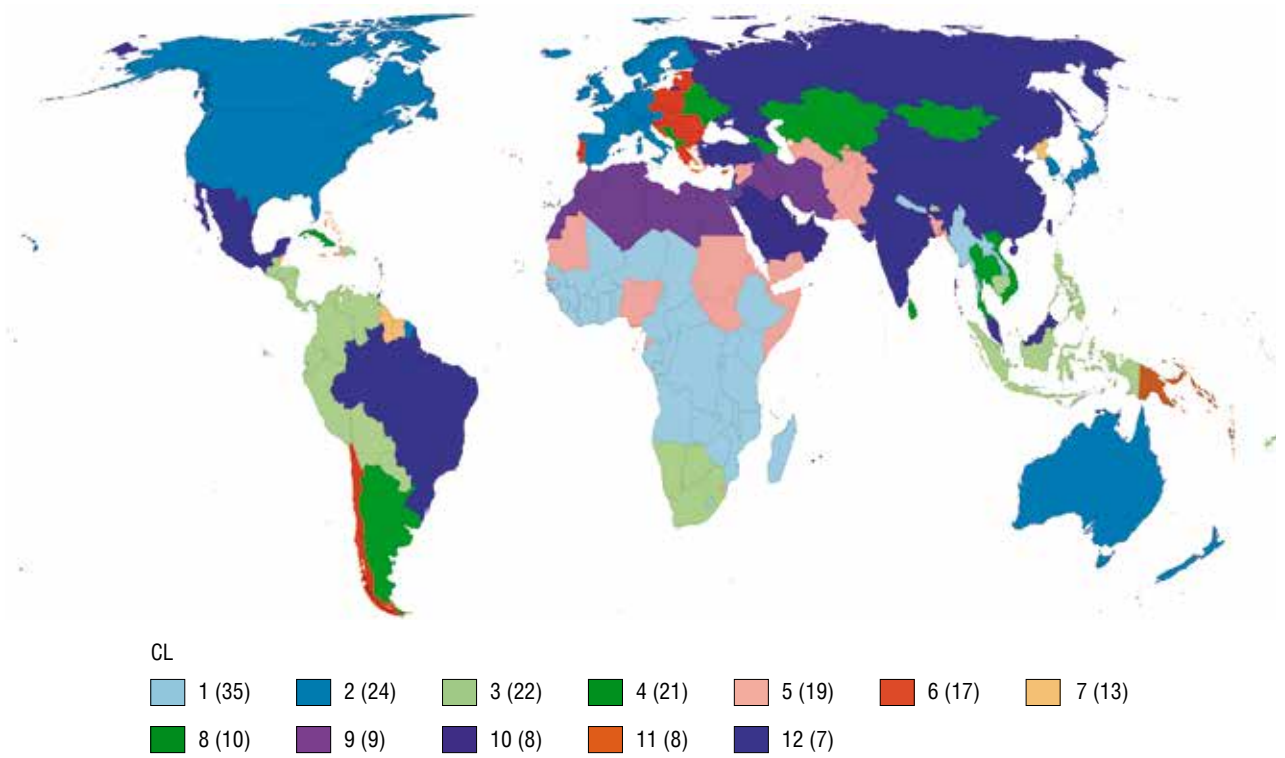


Fig. 12.13. Twelve k-median clusters without centroids

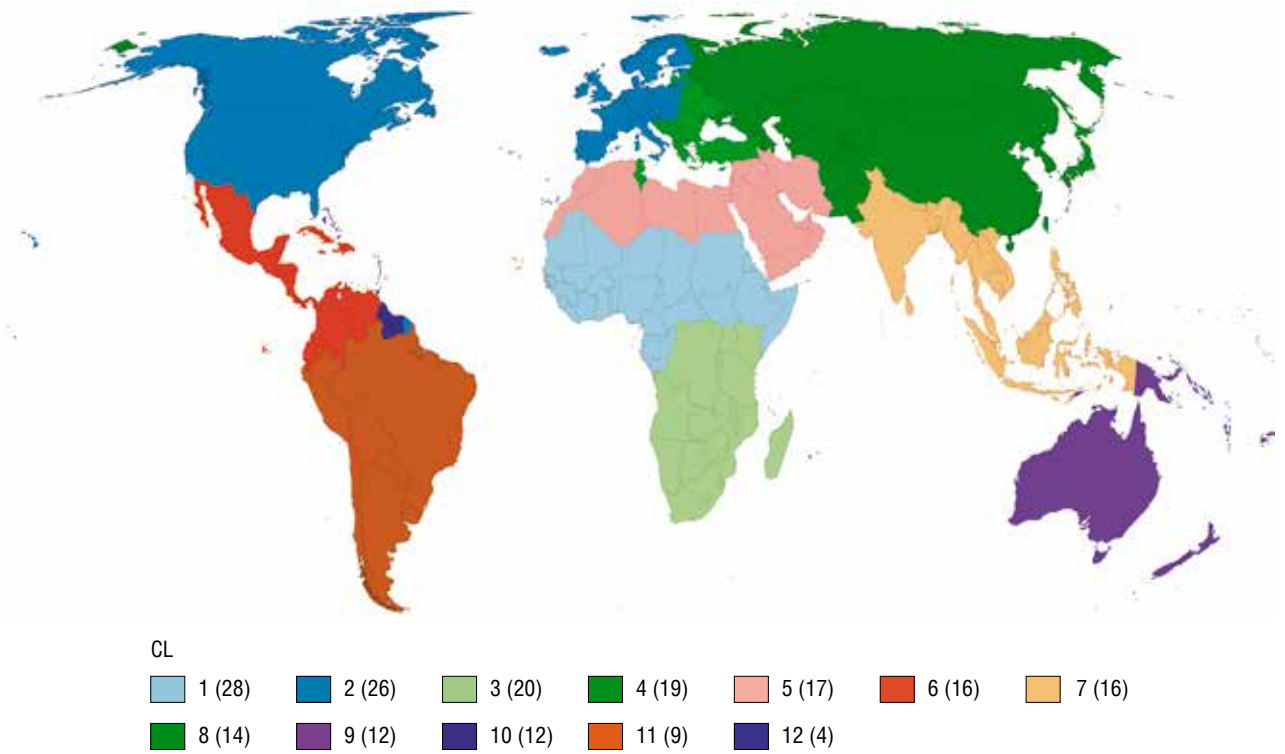


Fig. 12.14. Twelve k-median clusters with centroids

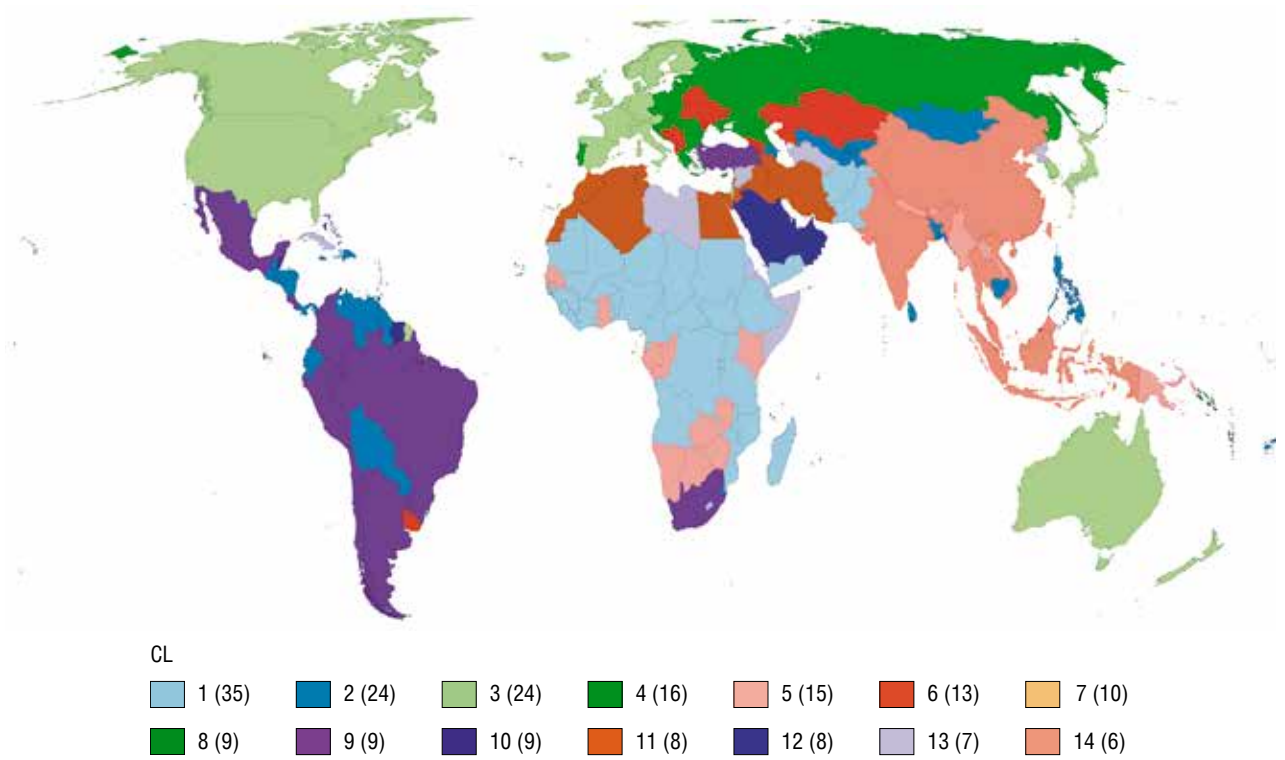


Fig. 12.15. Fourteen k-median clusters without centroids

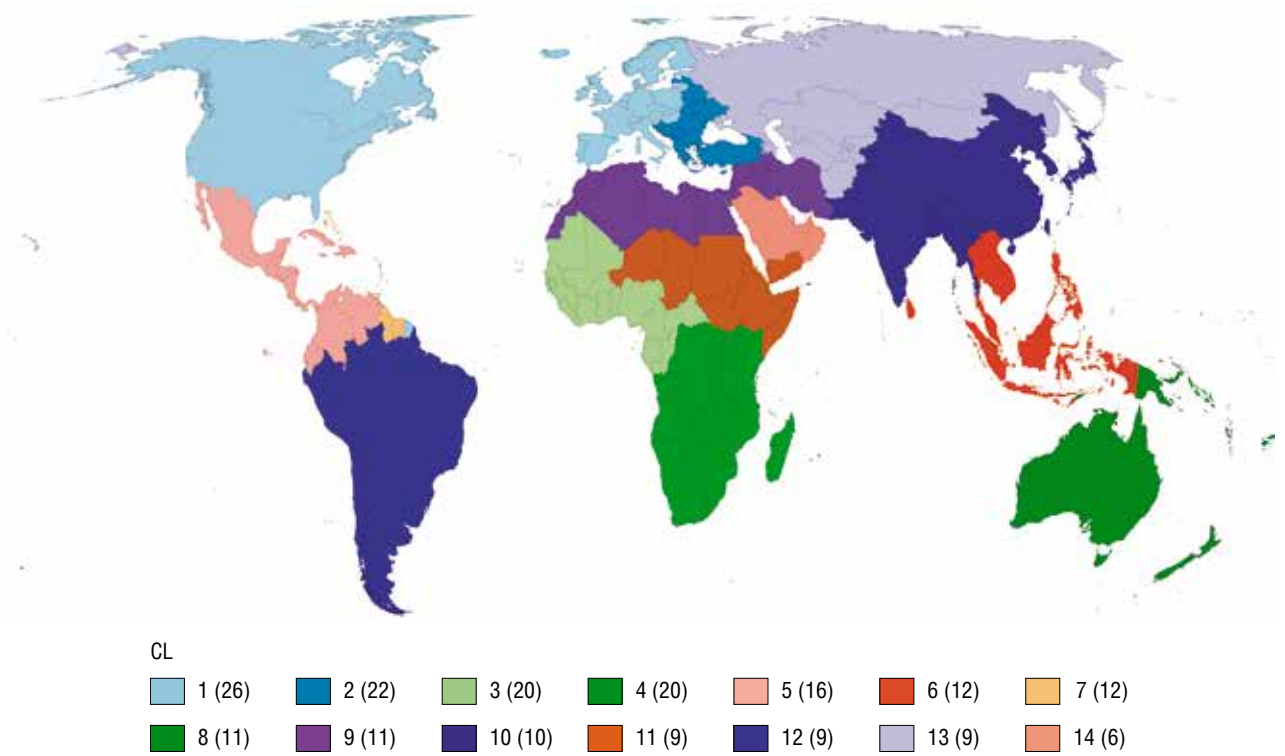


Fig. 12.16. Fourteen k-median clusters with centroids

Curiously, Saudi Arabia and Oman are joined in their cluster by Suriname. As we have repeatedly stated, Saudi Arabia and Oman are united by the fact that their economies are based on the extractive industries. Apart from this, there are no other similarities to speak of, and we can thus state that Suriname is a deviant here.

It is no coincidence that South Sudan, Somalia and Eritrea form a cluster. Each of these states is experiencing hardships, for various reasons. South Sudan gained independence in 2011 as the result of a referendum held after a protracted armed conflict. The country's economy depends on oil, but all the pipelines are controlled by Sudan. The situation is complicated by the disputes over certain areas of the country and the lack of internal homogeneity, which led to a civil war that lasted from 2013 to 2020. Epidemics and famine plague South Sudan. And Somalia fairs no better in this regard. The country quite literally fell off the map for many years due to civil war, and it was not until 2012 that relative order was restored. This all led to a massive decline in all spheres of life, and the economy, if it can be called that, mostly operates in the shadow sector. Eritrea is, for its part, one of the poorest countries in the world, and has a command economy. And, on top of that, it has been greatly weakened by conflicts with the more powerful Ethiopia, which brought massive costs with absolutely no benefits.

By this point, the division of the world has become even more interesting, as almost all the stable clusters have disintegrated, with the exception of those in South America and Melanesia (Fig. 13.17 and Fig. 13.18). Mexico has detached itself from the countries of the Isthmus of Panama and South America. Africa has collapsed cluster-wise, with the boundaries of the grouping in the South contracting, and a new cluster in the centre of the continent emerging. The following clusters can thus be identified, when spatiality is taken into account:

1. A cluster of countries of Eastern and Southern Europe, Turkey.
2. Canada, the countries of Western Europe, the Scandinavian countries.
3. The countries of the Indian subcontinent and Indochina, Indonesia.
4. The CIS countries, China, Japan, Pakistan, Afghanistan.
5. The countries of Western Africa.
6. The countries of Southern Africa.
7. The countries of Central Africa.
8. The countries of South America and the Isthmus of Panama.
9. The countries of the Middle East.
10. The countries of Melanesia.
11. Guyana, Senegal, Trinidad and Tobago.
12. The countries of Eastern Africa, Yemen.
13. The countries of South America, minus its northern part.
14. The countries of Northern Africa.
15. Mexico, the Caribbean countries.
16. The island states of Micronesia.
17. The Caribbean islands.
18. The United States.

Particularly interesting is the positioning of the United States in its own cluster. The United States is indeed unlike other powers, which is mainly due to the combination of military and economic power, as well as its geographic isolation from its competitors. However, it still belongs to the cluster that includes Western European countries and Canada the cartogram that does not account for centroids, which is largely due to its leading position in terms of economic and social development. Brazil has ditched its neighbours from previous clusters to join China, Mexico, India and Indonesia. This, as far as we can tell, is largely due to environmental indicators. Brazil is actively tearing down its rainforests, which leads to an ecological disaster in a number of regions. The situation in India and China is no better — as industrial powerhouses, they naturally produce extremely high levels of pollution, especially in the metropolitan areas of Beijing and

New Delhi. An important role in the formation of this cluster is played by indicators of social wellbeing and mobility, which remain low in these countries.

The Eastern European cluster has finally broken into two groups. Serbia, Bosnia and Herzegovina, Montenegro, Ukraine and Belarus are in a cluster with Kazakhstan, Armenia and Georgia. Many of these countries are experiencing prolonged crises as a result of wars or political struggles. Corruption is rampant in these states, and social mobility is low compared to countries in the neighbouring Western European cluster. Russia falls into the cluster of Eastern European countries, which mostly agrees with the general socioeconomic problems of the countries that emerged after the fall of the communist regimes in the region.

This is our final cluster division (Fig. 12.19 and Fig. 12.20). Interestingly, despite the greatly increased number of groups, a certain level of continuity remains, especially for the United States, Canada and Western European countries. The countries of South America form a single cluster, and the cluster of Mexico, the countries of the Isthmus of Panama and the northern part of South America is back. The stability of the grouping of MENA countries has been preserved, although Saudi Arabia and Oman are not in that cluster, which have traditionally existed in their own “bubble.” The changes have affected the cluster of CIS countries: those in Central Asia have broken off into a separate cluster, while Russia has joined China and Japan. This gives us the following clusters:

1. The United States, Canada, Western and a part of Eastern Europe.
2. Southern and Eastern Europe, including Turkey.
3. Mexico, the countries of the Isthmus of Panama, the countries of South America.
4. Central Africa.
5. Indochina and the Philippines .
6. Southern Africa and Madagascar.
7. Suriname, Guyana, Trinidad and Tobago, the Caribbean islands.
8. The MENA countries.
9. Papua New Guinea and the island states of Micronesia.
10. The countries of South America, minus the northern part.
11. The countries of Central Asia, Azerbaijan.
12. The countries of Eastern Africa, Yemen.
13. Australia, New Zealand, Indonesia.
14. Western Africa.
15. Saudi Arabia and Oman.
16. The countries of the Indian subcontinent.
17. Russia, China, Japan.
18. Mauritania and Senegal.
19. The European microstates.
20. Sri Lanka and the Maldives.

The cartogram non-adjusted for the spatial factor brings the United States, Canada and Western Europe together into a common cluster. Interestingly, a similar result is observed on the cartogram that does take the influence of centroids into account. We should note that this is a fairly stable pattern, especially considering that similar results were observed on cartograms with a smaller number of clusters. The countries are indeed similar, although not in every aspect. For example, ecology and security indicators are better in the countries of Western Europe, but the United States beats them all in economic development. History is also behind the sustainability of this cluster, as they have been close partners for 70 years.

The eighth cluster is particularly interesting, because its borders include countries that are members of BRICS or want to join the association. BRICS is gradually growing in strength, and the desire of its members to increase coordination within the organization can be seen already. It is possible that BRICS will transform into a political club or union in the future. The BRICS countries account for 26% of the Earth's territory, 42% of the world's population (2.83 billion people) and 27% of global GDP.

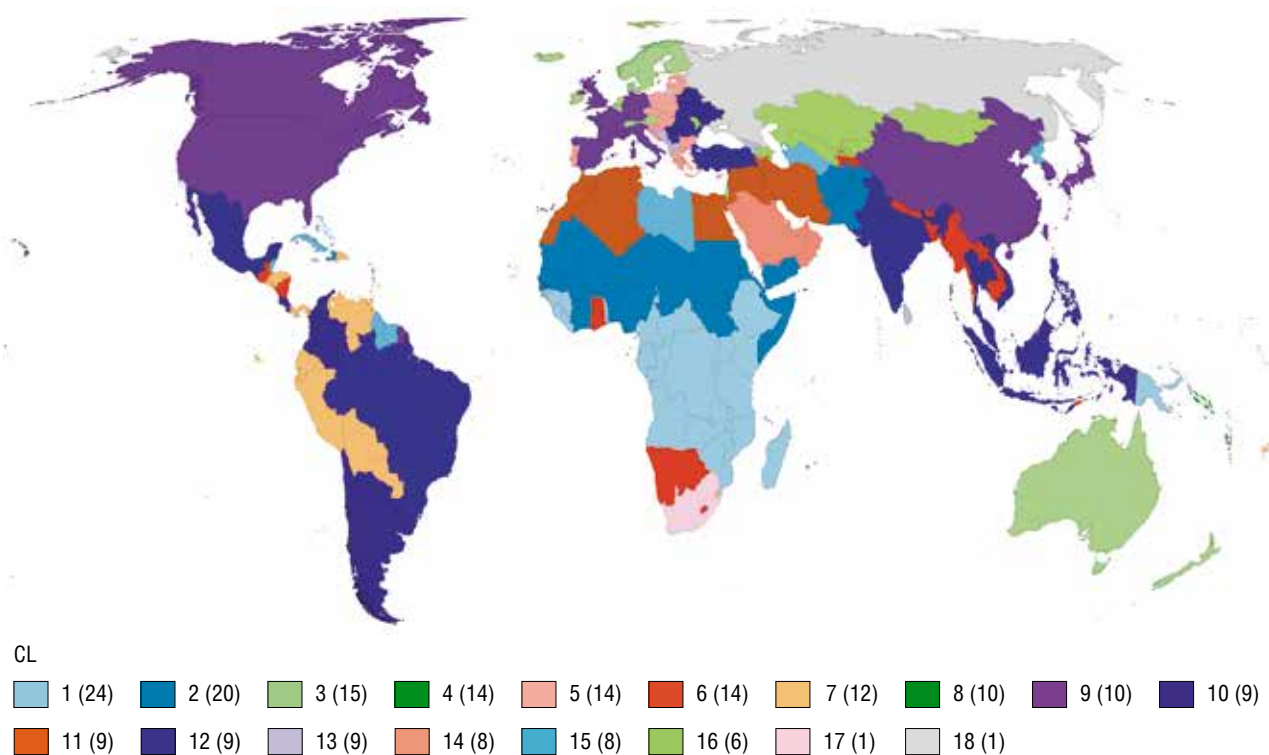


Fig. 12.17. Eighteen k-median clusters without centroids

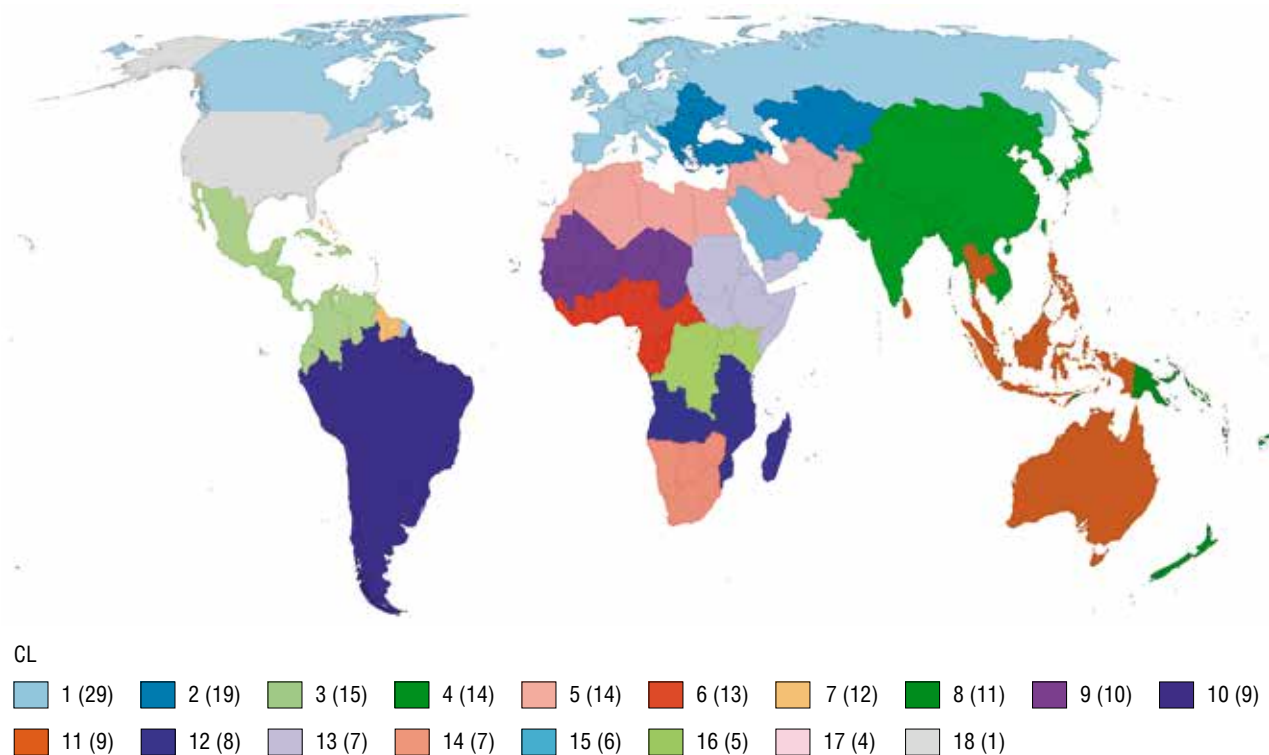


Fig. 12.18. Eighteen k-median clusters with centroids

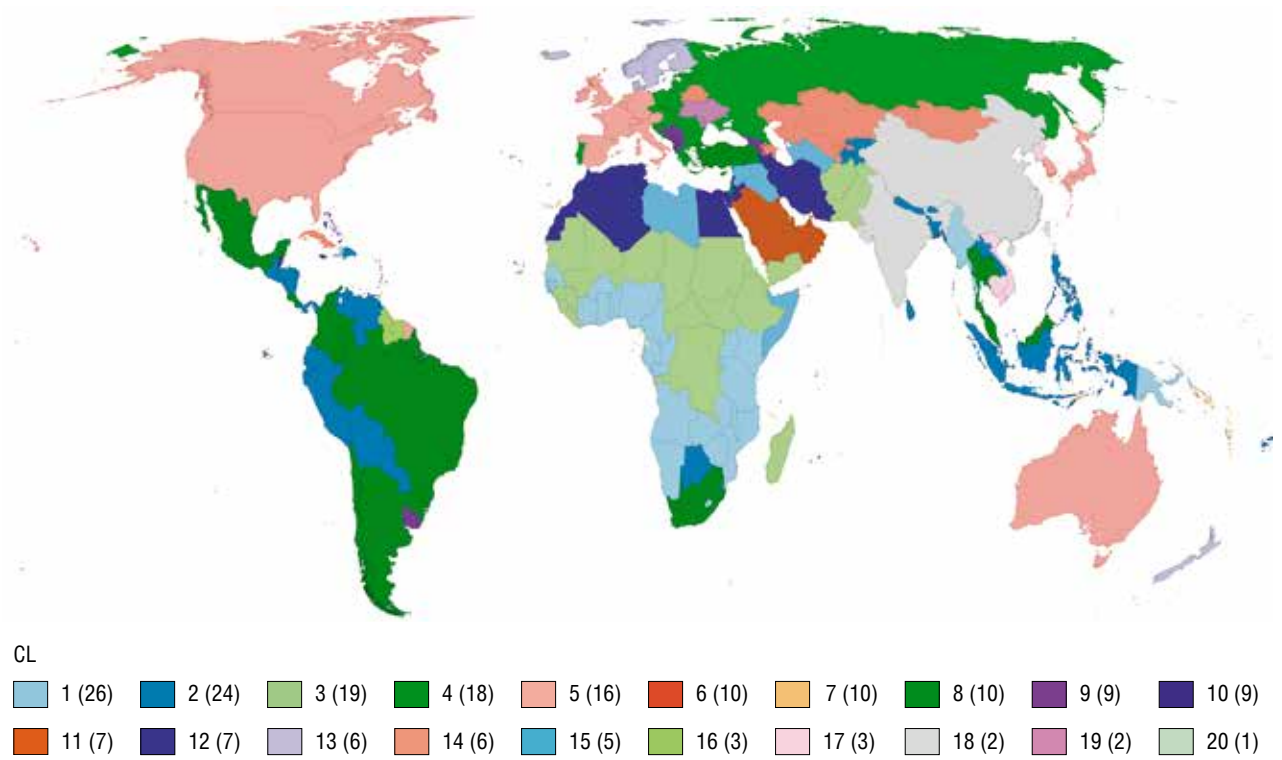


Fig. 12.19. Twenty k-median clusters without centroids

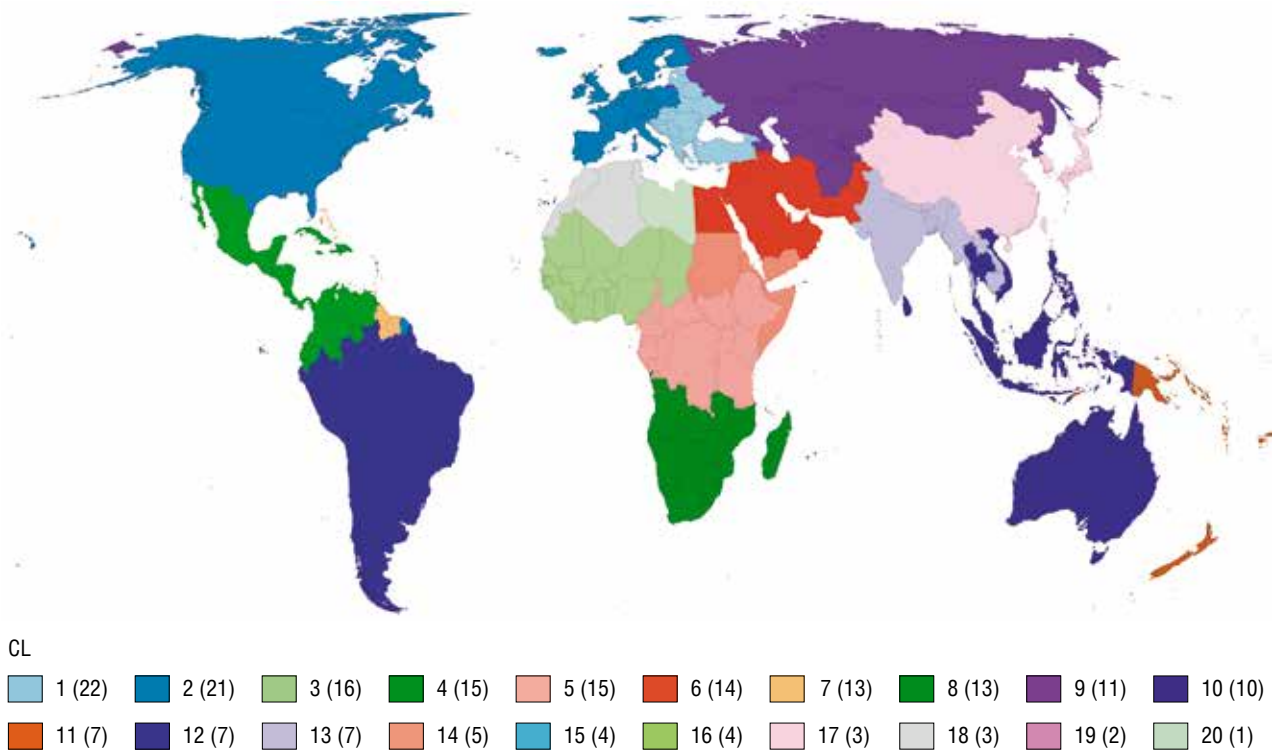


Fig. 12.20. Twenty k-median clusters with centroids

13

*Multi-
dimensional
Scaling*

Multidimensional scaling allows us, using the data we have collected, to assess the modern world order in terms of the similarities and differences between states. The closer the points on the diagram are, the more similar the objects under consideration are to each other, and vice versa.

The multidimensional scaling algorithm generates a space made up of 100 dimensions based on the data collected (the number of coordinates in accordance with the number of indicators we are analysing), which is impossible to conceptualize, much less represent on paper. This space contains points, each of which represents a state, and the coordinates of the points depend on the totality of the available indicator values.

Multidimensional scaling allows us to reduce the number of dimensions and simplify this mathematical model to a two- or three-dimensional space in which the distance between individual points will match, as much as possible, the distance between them in the hundred-dimensional space.

An interpretation of the multidimensional scaling scatter plot (Fig. 13.1) makes it possible to determine, in isolation from geographic location, how similar or different countries are within individual political blocs, as well as to find trends in the formation of clusters of states that are similar to one another.

Our description of the results of multidimensional scaling will deal with each quadrant of the diagram and political and economic regional integration associations.

Quadrant I is made up primarily of underdeveloped states located extremely close to each other on the diagram. This part of the diagram includes most of the countries of Africa, with the exception of the Seychelles, Mauritius (which are located in Quadrant III), as well as Libya, Tunisia, São Tomé and Príncipe, Cape Verde and Kiribati (which can be found in Quadrant IV).

This group also includes more “backwards” countries on other continents. For example, Afghanistan, Yemen, Iraq, Nepal, Bangladesh and Myanmar are also included in a dense cluster of dots made up primarily of countries in sub-Saharan Africa. A little further away are the Central African Republic, Chad, Somalia and Nigeria. We can thus conclude that this part of the diagram includes economically weak states, some of which have limited statehood.

A similar connection between geographic proximity and the “similarity” of states cannot be discerned in Quadrant II. Two countries that are very distant from each

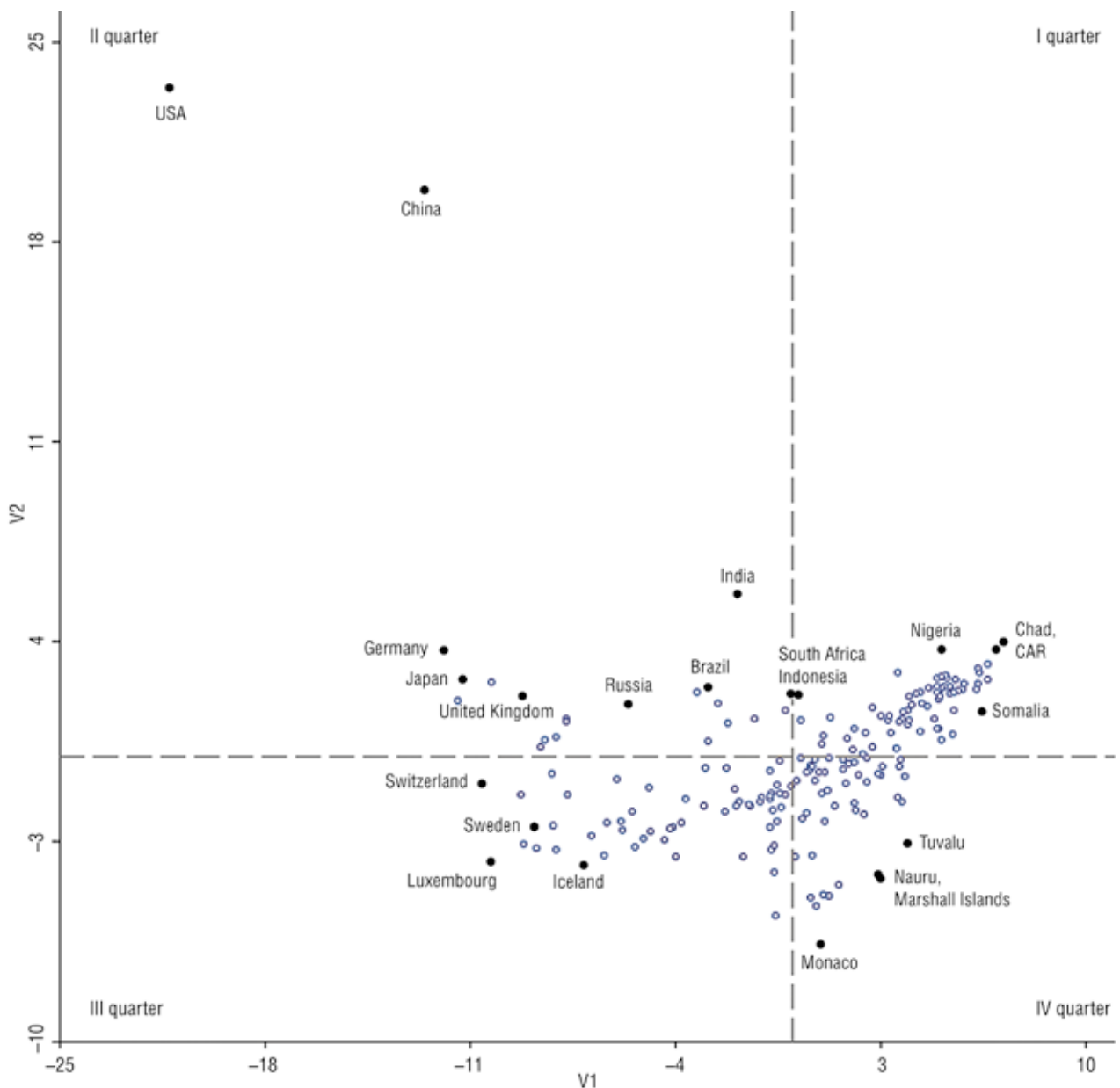


Fig. 13.1. Multidimensional scaling scatter plot

other stand out here — the United States and China. Their specific location on the diagram is due to the fact that, in terms of the totality of the indicators we have looked at, they are markedly different from the other countries of the world and can thus only be compared with each other.

This quadrant contains three more BRICS countries: Russia, Brazil and India, countries that “aspire” to be like the United States and China. The scatter plot allows us to trace the dynamics of these countries — it is likely that these states will move even further away from the general cloud of points. While India and Russia are somewhat “on their own” here, Brazil is close to two other emerging economies, namely Turkey and, to a lesser extent, Mexico. The last BRICS country, South Africa, is located on the border of Quadrant I and Quadrant II, which means that it is closer to the cluster of “backwards” states, although there is every reason to believe that the gap between them will increase and South Africa will move closer to the group of countries in Quadrant I. It is also interesting that the country closest to South Africa in terms of its position in the scatter plot, and thus most similar to it, is Indonesia.

The left-hand portion of Quadrant II consists of a cloud of developed democracies, including the United Kingdom, France, Germany, Japan and the Netherlands. Canada, Ireland, South Korea, Spain and Italy are located to the right of them in a more compact group, and the points of the latter two almost intersect, which would indicate that they are extremely similar in terms of their levels of development.

Quadrant III consists of states with different political systems and different levels of economic development, which makes it difficult to discern any kind of pattern for classifying the countries into a single group. The quadrant includes several European countries, Australia, New Zealand, Argentina, Kazakhstan and Israel, as well as a number of small states, for example, Saint Kitts and Nevis, Singapore, Malta, Brunei, Bahrain and Qatar.

What is interesting here is that there are several pairs of states whose points on the diagram almost completely coincide. For example, the cumulative results for the 100 indicators we looked at demonstrate that Belarus–Uruguay, Serbia–Qatar, Kuwait–Montenegro, and Georgia–Costa Rica are extremely similar to each other. A triad of countries — Bahrain–Mauritius–North Macedonia — is also being formed.

Quadrant IV contains a number of post-Soviet countries (Turkmenistan, Azerbaijan, Uzbekistan and Kyrgyzstan), as well as Mongolia, North Korea, Syria, Libya, Oman, Paraguay and Ecuador. There are no obvious patterns that would allow us to group these countries together either.

This quadrant also includes the majority of the world's microstates. In the two-dimensional space, we can see that some of them are actually located far from the general cloud of countries, although this pattern is far more visible when the mathematical model is expanded to three-dimensional space (Fig. 13.2). The group of countries that appears on the three-dimensional model includes Tuvalu, Palau, Nauru, the Marshall Islands, Andorra, Monaco, San Marino, Liechtenstein, Saint Kitts and Nevis, and Antigua and Barbuda. Monaco in particular stands out here, as it is located farther than the other countries along the Z axis. Dominica, which in two-dimensional space can also be said to belong to this cluster, is located far from it in three-dimensional space and is thus not a part of this group of countries.

Multidimensional scaling also allows us to assess how similar the members of individual political and economic regional integration associations are. Each association has its own type of clustering, which can be either significant or relative, or absent altogether.

Significant clustering — and thus the greatest “similarity” of states — is observed in four associations: EAC–IGAD; SACU–SADC; UEMOA–ECOWAS and CA-4–CAIS. This allows us to conclude that these regional blocs unite countries with more or less the same level of political, economic and social development.

There is no discernible clustering for two large blocs: NATO–EU–EFTA–EUCU–SAA/AA; and ASEAN+3. These blocs are made up of countries that are most distant, and thus most “different” from each other. The composition of these associations is heterogenous, since they each contain states with various levels of development, and in the case of the NATO–EU–EFTA–EUCU–SAA/AA bloc, there is no geographic proximity either, something that would simplify the processes of international trade and cultural exchange.

The remaining integration associations demonstrate relative degrees of clustering in the multidimensional scaling diagram.

In addition to geographic proximity, the members of the EAC–IGAD association are characterized by their similar sectoral structures, the specifics of their economic development, their cultural proximity, and a more or less equal level of social development. The historical development of the countries of the sub-region also played a role: the three founding countries of the EAC (Kenya, Tanzania and Uganda) were once British colonies, and the policy of that country contributed to the development of ties between countries, which only strengthened after they achieved independence. The most similar states in this bloc at the present time are Ethiopia–Uganda and Kenya/Rwanda. South Sudan leans more to the right of the chart due to the lower levels of socioeconomic development and the lack of data for a number of indicators (Fig. 13.3).

The UEMOA–ECOWAS group also includes countries of sub-Saharan Africa. As in the case of the EAC–IGAD association, the dense cloud of countries in Quadrant I unites states with a similar level of social

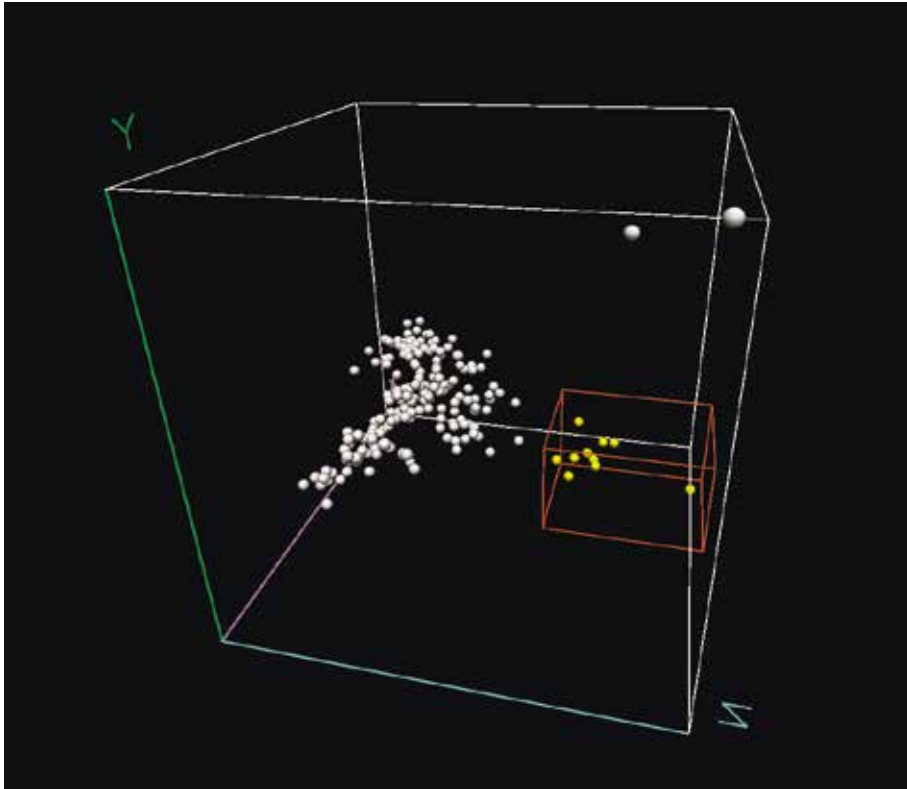


Fig. 13.2. Three-dimensional model based on the results of multidimensional scaling

and economic development (Fig. 13.4). However, there is one exception to this bloc — Cape Verde, whose closest neighbour in this chart is Azerbaijan. Its isolation from other countries in the association is explained by its high (for this bloc) economic and social development indicators. The large amount of available statistics also affects its location in multidimensional space.

The SACU–SADC bloc consists of the countries of Southern Africa, which differ somewhat in terms of their development level. Here, three states stand out from the general group: South Africa, Mauritius and the Seychelles. South Africa gravitates towards the group of leading states located in Quadrant II, while Mauritius and the Seychelles find themselves in a cloud of small states located in Quadrant III (Fig. 13.5). The Democratic Republic of the Congo and the Comoro Islands are located a small distance from this cloud.

Like the other regional blocs in sub-Saharan Africa, CEMAC–ECCAS is characterized by a high level of clustering. All of the countries of this association, with the exception of São Tomé and Príncipe, are located in Quadrant I (Fig. 13.6). There are no obvious outliers in this group, although the poorest and most politically unstable countries (the Central African Republic and Chad) are located a distance away from the rest and are the most similar countries in the group. When analysing the multidimensional scaling chart, it is important to take into account the fact that statistical research in underdeveloped countries is severely lacking in most cases. For example, the Central African Republic does not have any data whatsoever for one quarter of the indicators analysed in this atlas; Equatorial Guinea does not have any figures for one third of the indicators; and Somalia does not have any for almost half of them. If more statistical data were available, the clustering of points on the diagram would have a slightly different configuration, which can be put down to the specifics of multidimensional scaling as an analysis tool. That notwithstanding, qualitative studies of the countries in sub-Saharan Africa suggest that more complete data would not affect these countries in terms of their belonging to Quadrant I, rather, it would only slightly change their position relative to each other.

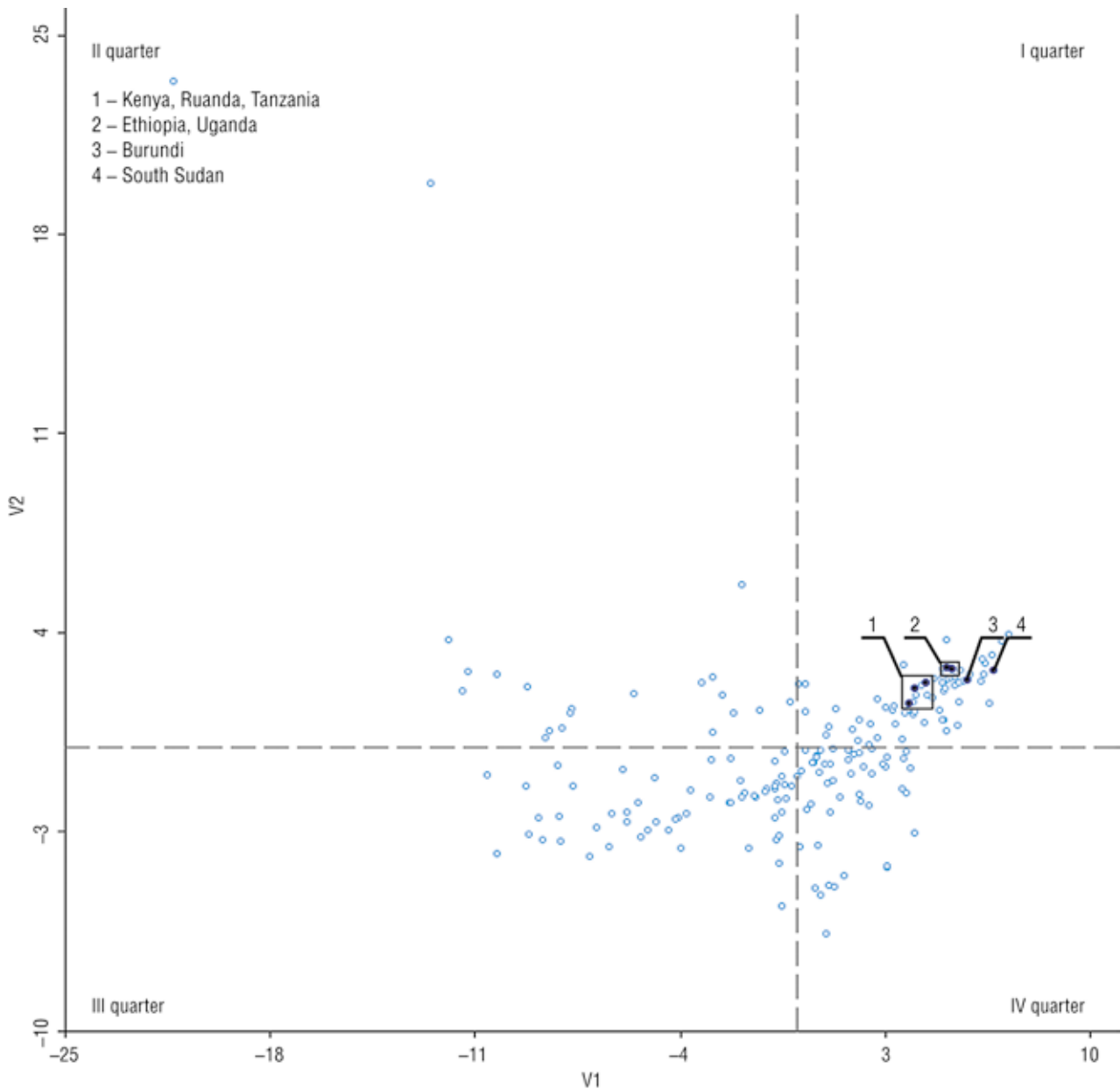


Fig. 13.3. EAC-IGAD

While countries of Central America that belong to the CA-4-CAIS bloc are located in three of the quadrants on the diagram, they are nevertheless grouped rather close to each other, which allows us to conclude that there is significant clustering here (Fig. 13.7). Panama and Costa Rica — countries with more stable political institutions and superior economic development compared to the other states in the region — appear in Quadrant III. Nicaragua, Guatemala and Honduras, the least socioeconomically developed countries in the region, are naturally located on the right-hand side of the diagram, and the proximity of their respective points allows us to conclude that they are similar in many ways. The smaller states of this group (Belize, the Dominican Republic and El Salvador) are located in Quadrant IV, with Belize closer to the other three small countries in the region — Suriname, Jamaica and Saint Lucia.

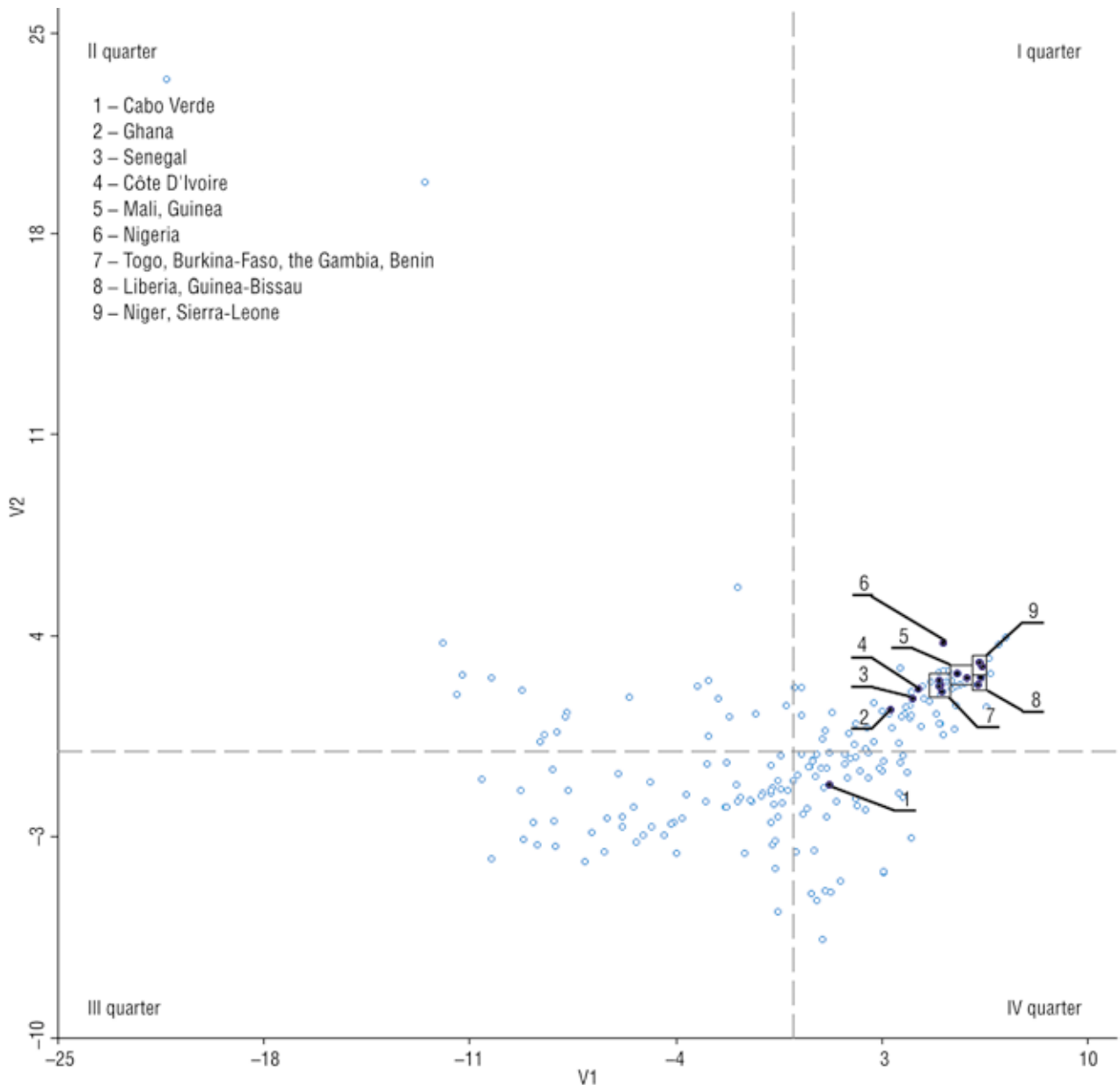


Fig. 13.4. UEMOA-ECOWAS

The OECS-CARICOM bloc includes the Caribbean countries, which have approximately the same level of economic and social development. Their location in the graph is enough to state that there is relative clustering, although we can see some countries converging (Fig. 13.8). All the countries in this association are small, and on the graph, they appear as part of a larger group of small countries located at the bottom of the diagram along the vertical axis. The only exception here is the unstable and economically weak Haiti, which is part of the cloud of “backwards” states in quadrants III and IV.

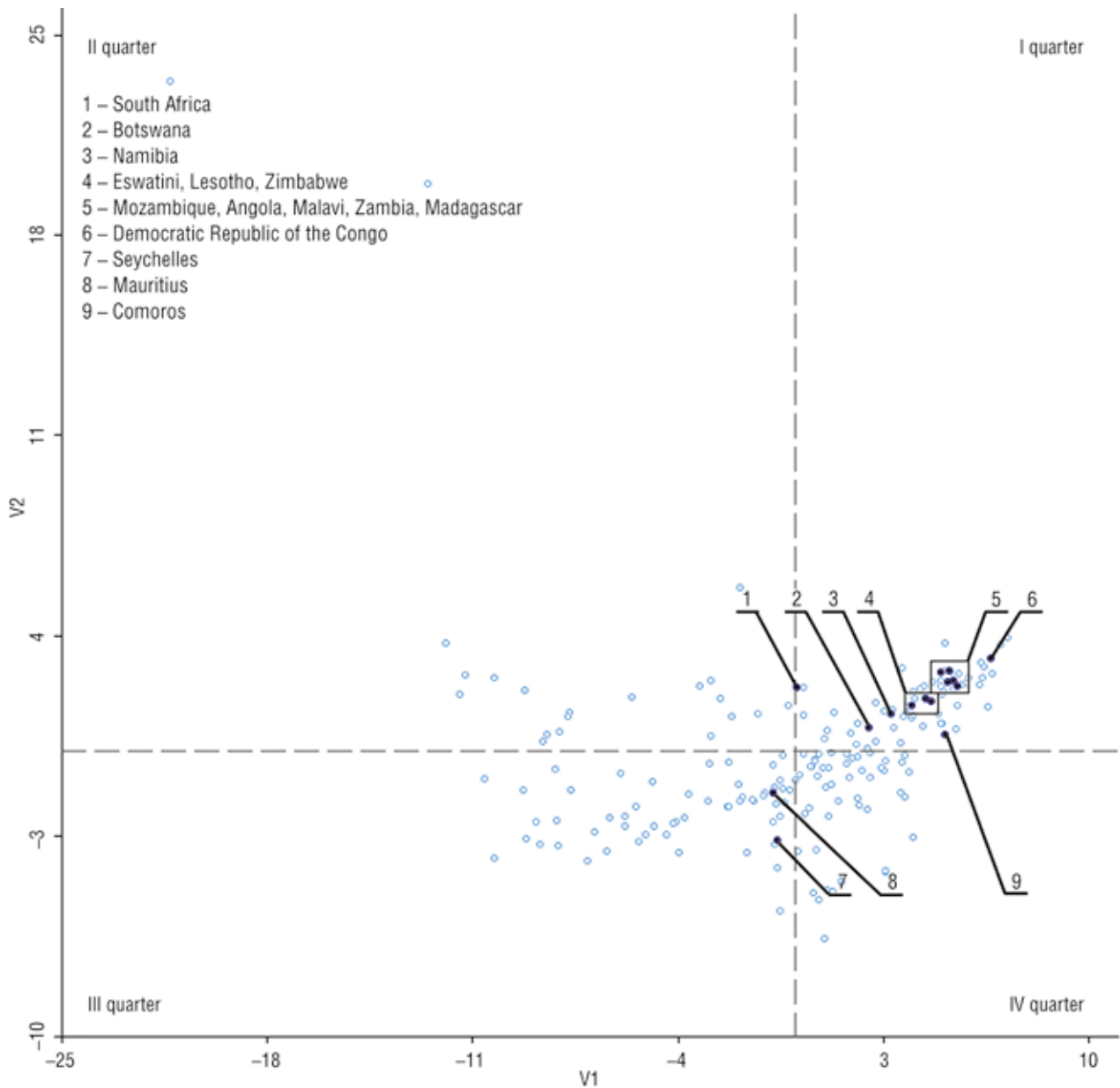


Fig. 13.5. SACU–SADC

The MERCOSUR–LAIA association includes countries with different levels of socioeconomic development, which explains the lower degree of clustering of the objects in the diagram (Fig. 13.9). The “stronger” countries of the region, Mexico and Brazil, are, of course, located in Quadrant II. Both countries are characterized by economic and political stability, and their cumulative GDP at purchasing power parity is over 60% of the GDP of all members of the bloc. Interestingly, Turkey is the country that is most similar to Brazil. Three countries of the region appear in Quadrant III, “aspiring” to the group of most developed countries. These are Chile, Argentina and Uruguay.

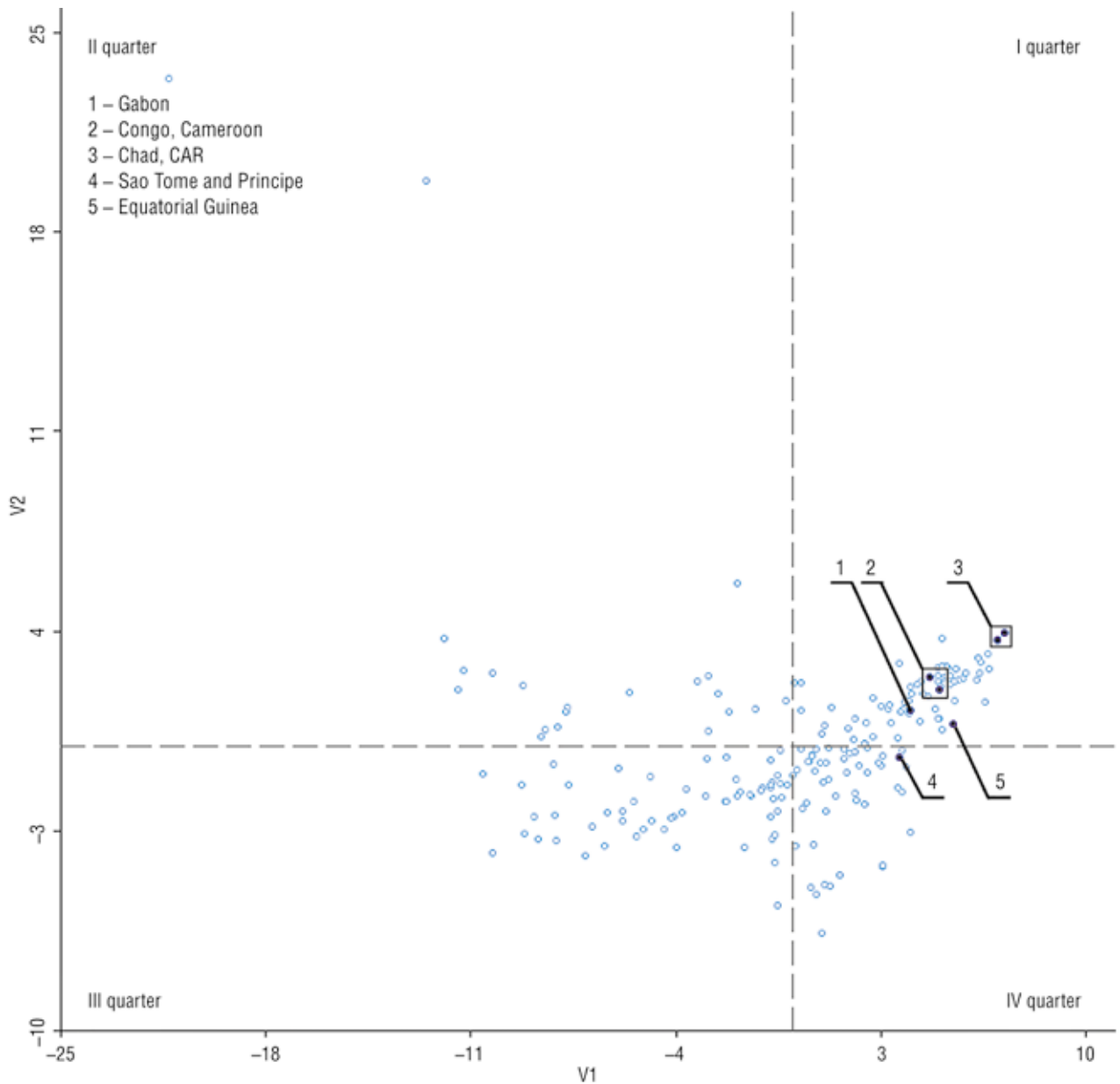


Fig. 13.6. CEMAC–ECCAS

The CSTO–EAEU–CIS countries also form an association with relative clustering, although they are relatively compactly located in a common point cloud (Fig. 13.10). The country that is most “dissimilar” to the others in the bloc is Russia, and the countries that are most similar to each other are Uzbekistan and Kyrgyzstan, which are located on the boundary lines between quadrants I and IV. The location of the points on the chart allows us to trace the course of the economic modernization of Kazakhstan and Belarus and their gradual convergence with developed countries, which are primarily located on the left-hand side of the chart, while Tajikistan and Turkmenistan, on the contrary, are closer to the least developed countries.

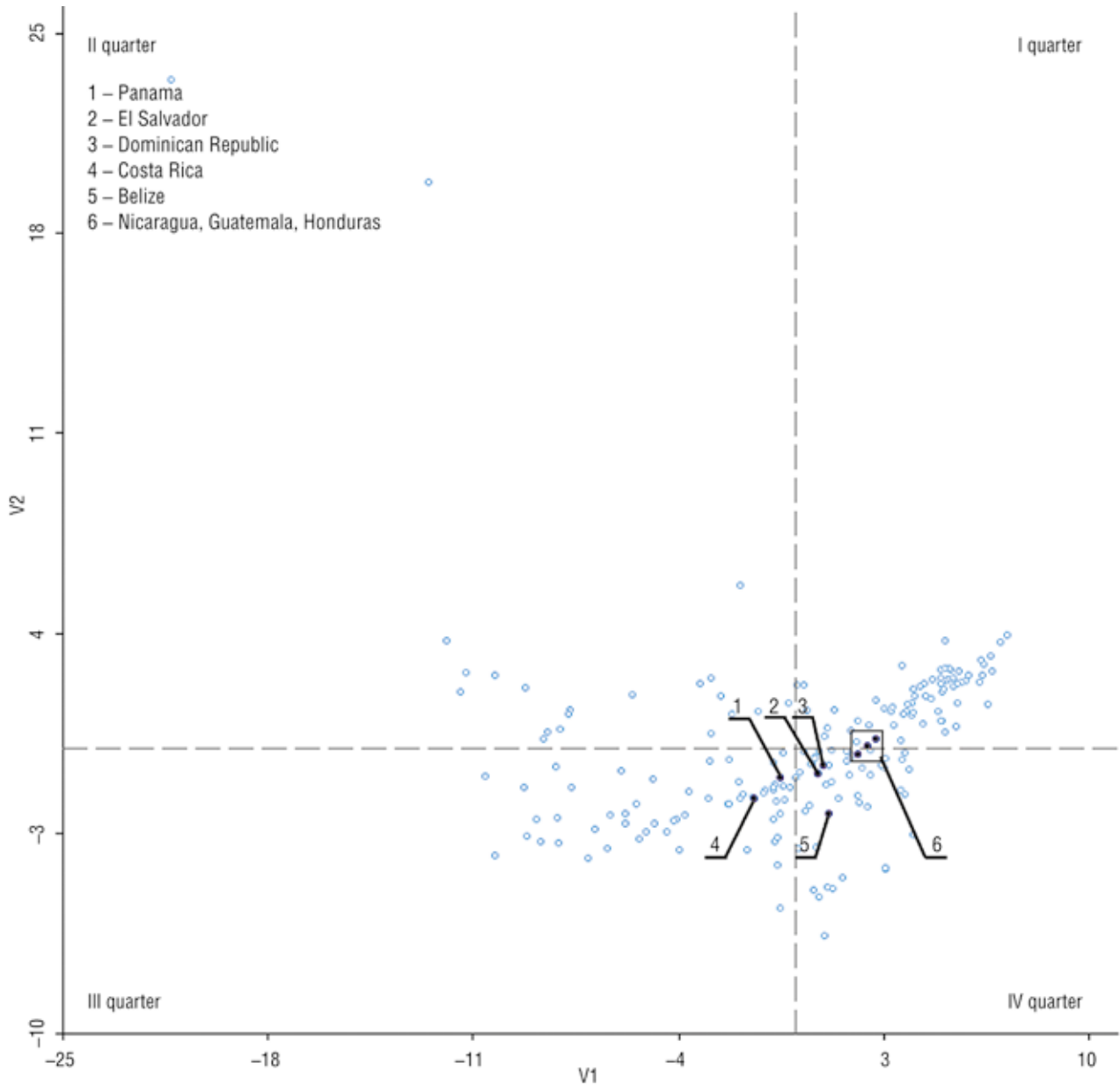


Fig. 13.7. CA-4-CAIS

The SAARC countries demonstrate a weaker correlation between the location of countries on the scatter plot and their membership in the bloc. India stands out as the most developed country of this bloc, located in Quadrant II and “catching up” with the leaders, the United States and China (Fig. 13.11). As for the other countries that make up this association, there is not a particularly significant spread in their values, with most of them being located on the right-hand side of the chart. Pakistan and Afghanistan are closest to the cloud of underdeveloped states, while the Maldives is naturally located closer to the other island states. Persisting political differences hinder the convergence of SAARC countries on the diagram and the development of integration processes, making cultural and economic interaction all the more complicated. This, in turn, can make the clustering of points on the chart over time even less significant.

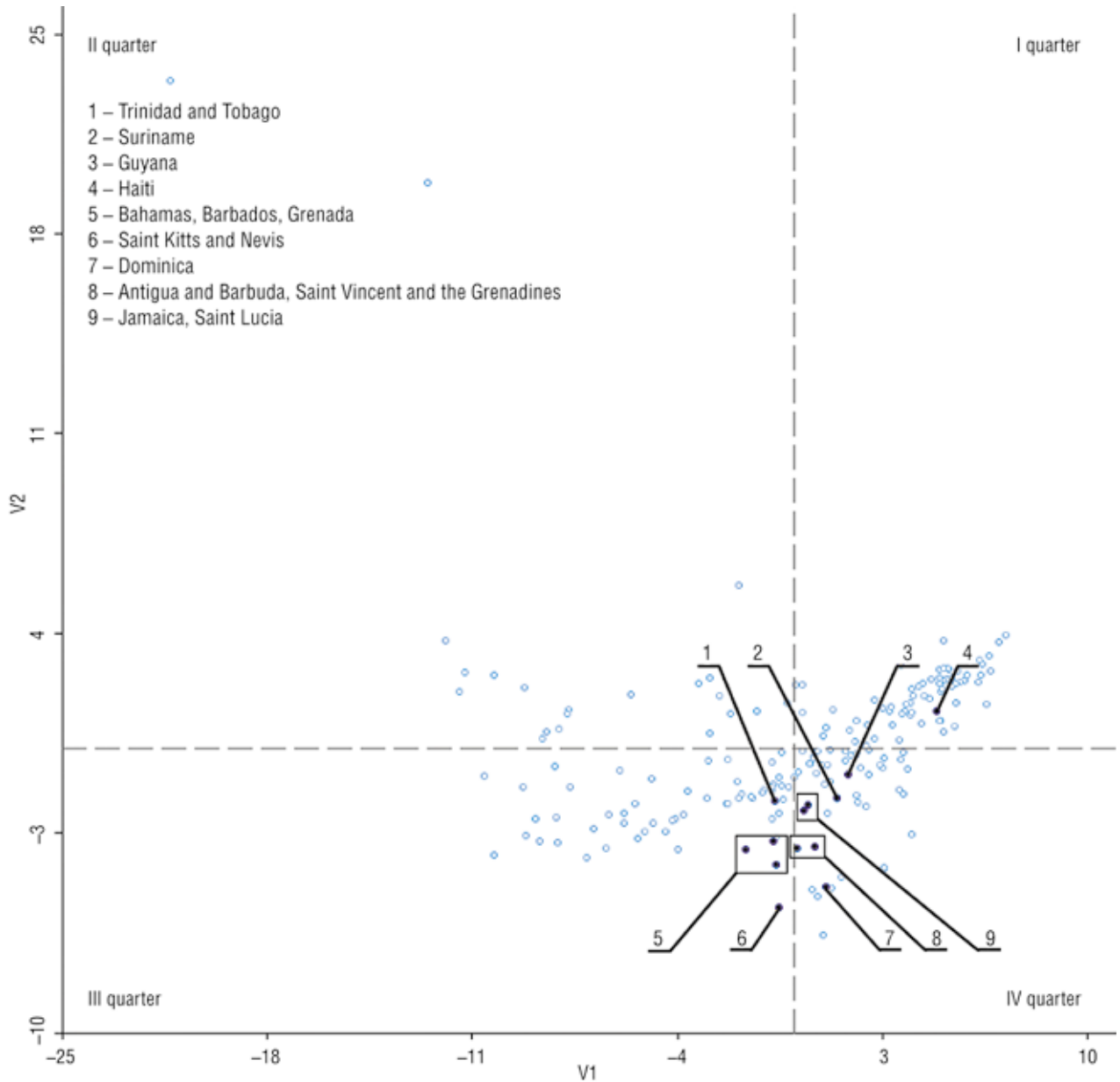


Fig. 13.8. OECS-CARICOM

The GCC-LAS bloc is also characterized by relative clustering, since the points are scattered and the states of the bloc are located in different quadrants (Fig. 13.12). The richest and most developed Arab states (the United Arab Emirates, Saudi Arabia, Kuwait, Bahrain and Qatar) are naturally located on the left-hand side of the graph. The remaining countries of the association, with the exception of the failed state of Somalia, form small groups. One of these is a group of “backwards” countries (Mauritania, Yemen, Sudan) located in the cloud of points in the first quadrant of the diagram. The politically unstable Libya and Syria are also close to each other.

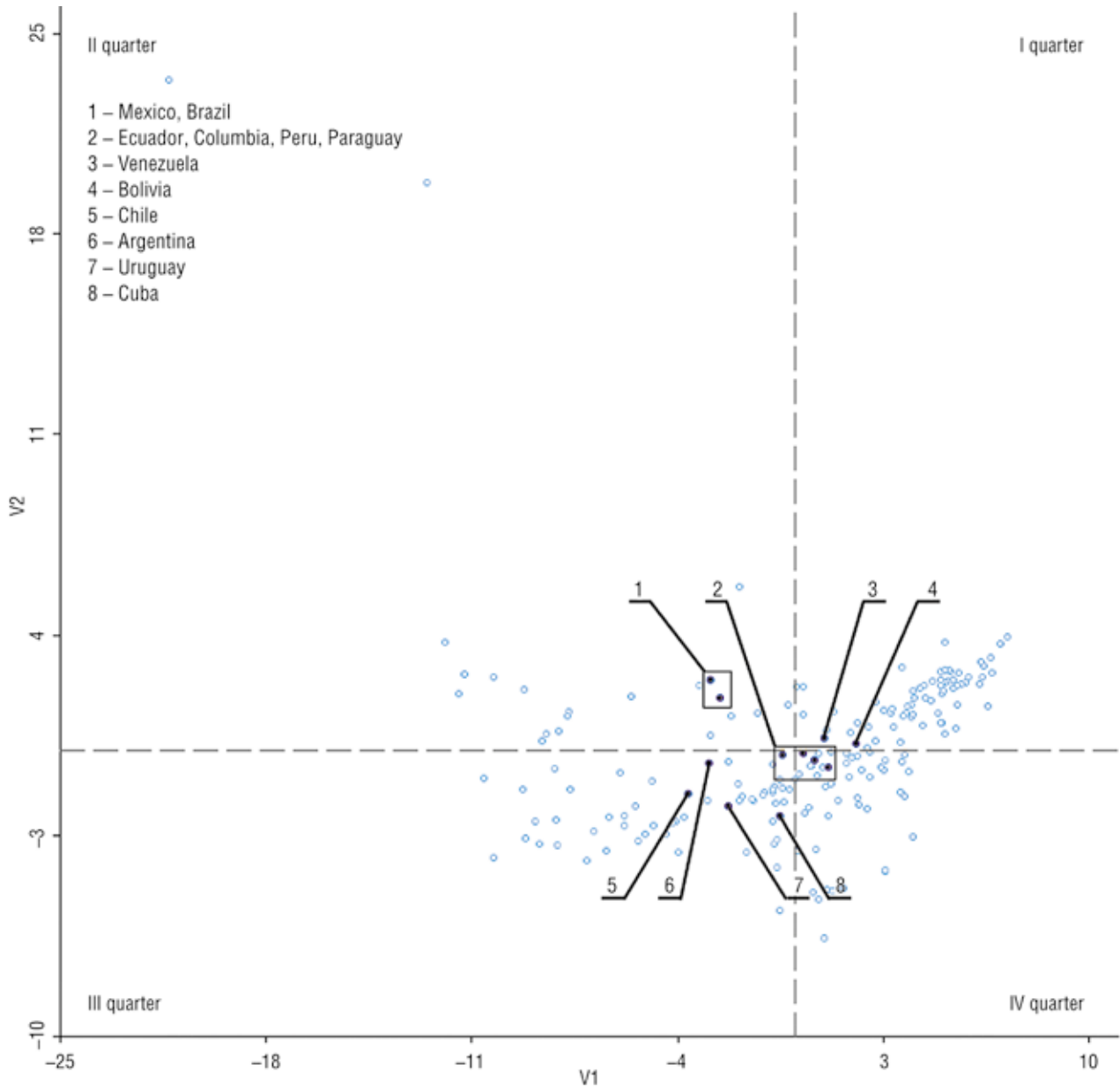


Fig. 13.9. MERCOSUR-LAIA

The ANZUS-CU bloc consists mainly of the small island states of Oceania located in Quadrant IV of the diagram (Fig. 13.13). Two clear exceptions to this group are Australia and New Zealand, which, in terms of their cumulative indicator scores, gravitate towards the group of countries with a developed democratic tradition. In general, Australia acts as a driver of the political and economic region, since the Pacific island states have almost no influence in these areas due to their small size, geographical isolation, remoteness from world trade routes, and poor infrastructural development. The only country of this bloc that is located in Quadrant I is Papua New Guinea, whose nearest neighbour on the diagram is Eritrea.

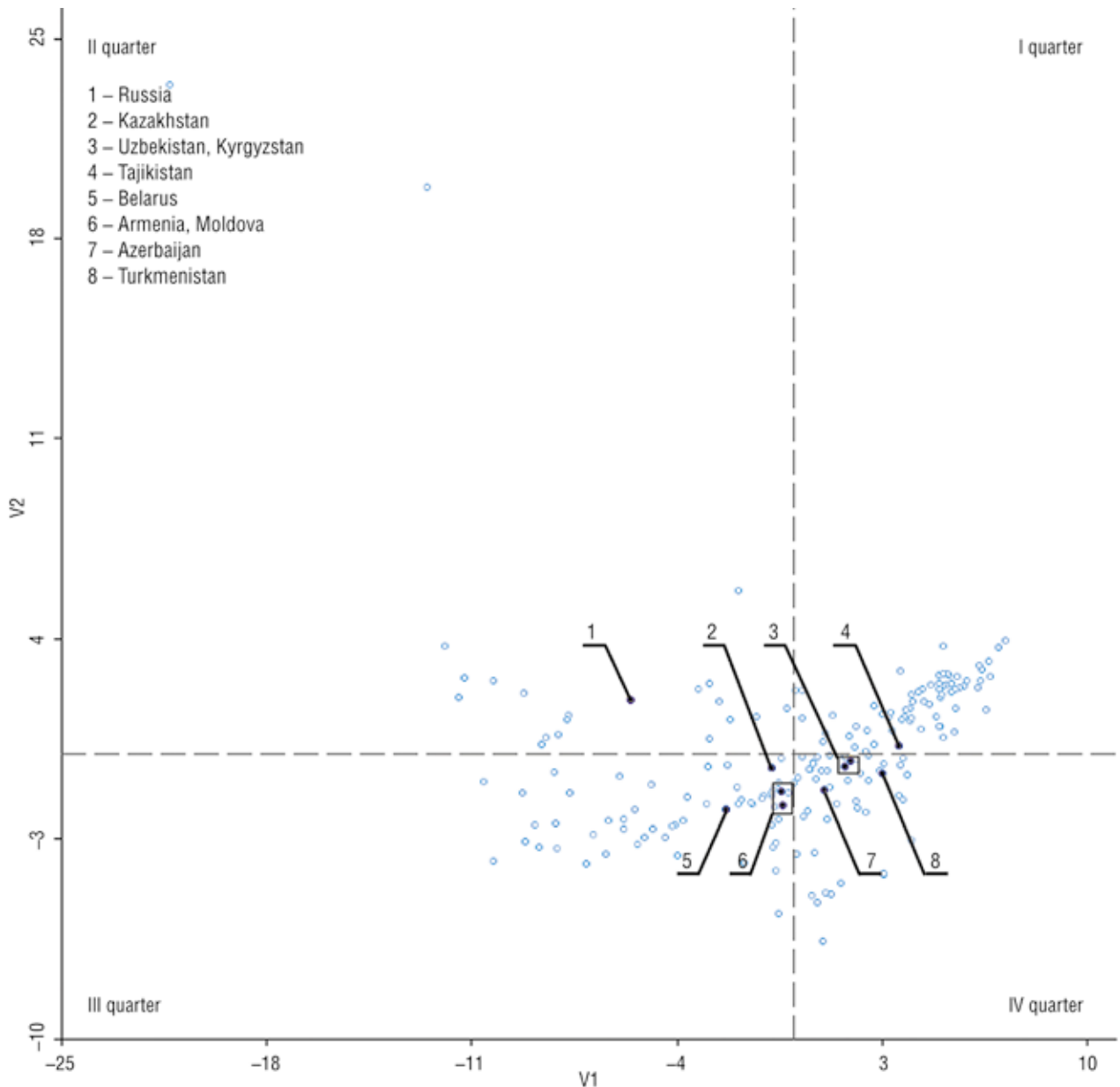


Fig. 13.10. CSTO–EAEU–CIS

The NATO–EU–EFTA–EUCU–SAA/AA bloc includes a great number of states, some of which can barely be distinguished from one another in terms of their socioeconomic indicators. This fact explains the lack of clustering in the diagram (Fig. 13.14). In particular, the remote location of the United States on the chart makes it almost impossible to compare it with any other country in this bloc. Most of the countries here are located on the left-hand side of the graph, with the only exceptions being the four “dwarf” states of Europe — Monaco, Andorra, San Marino and Liechtenstein. Despite the large spread of points on the chart and their relative distance from each other, the countries of this bloc can be divided into a number of groups. For example, the least economically developed countries of the Balkan Peninsula, as well as Ukraine and Georgia, are closer to the centre of the graph. The group of countries on the Scandinavia Peninsula also stands out, and Austria is similar to them in terms of cumulative indicator scores.

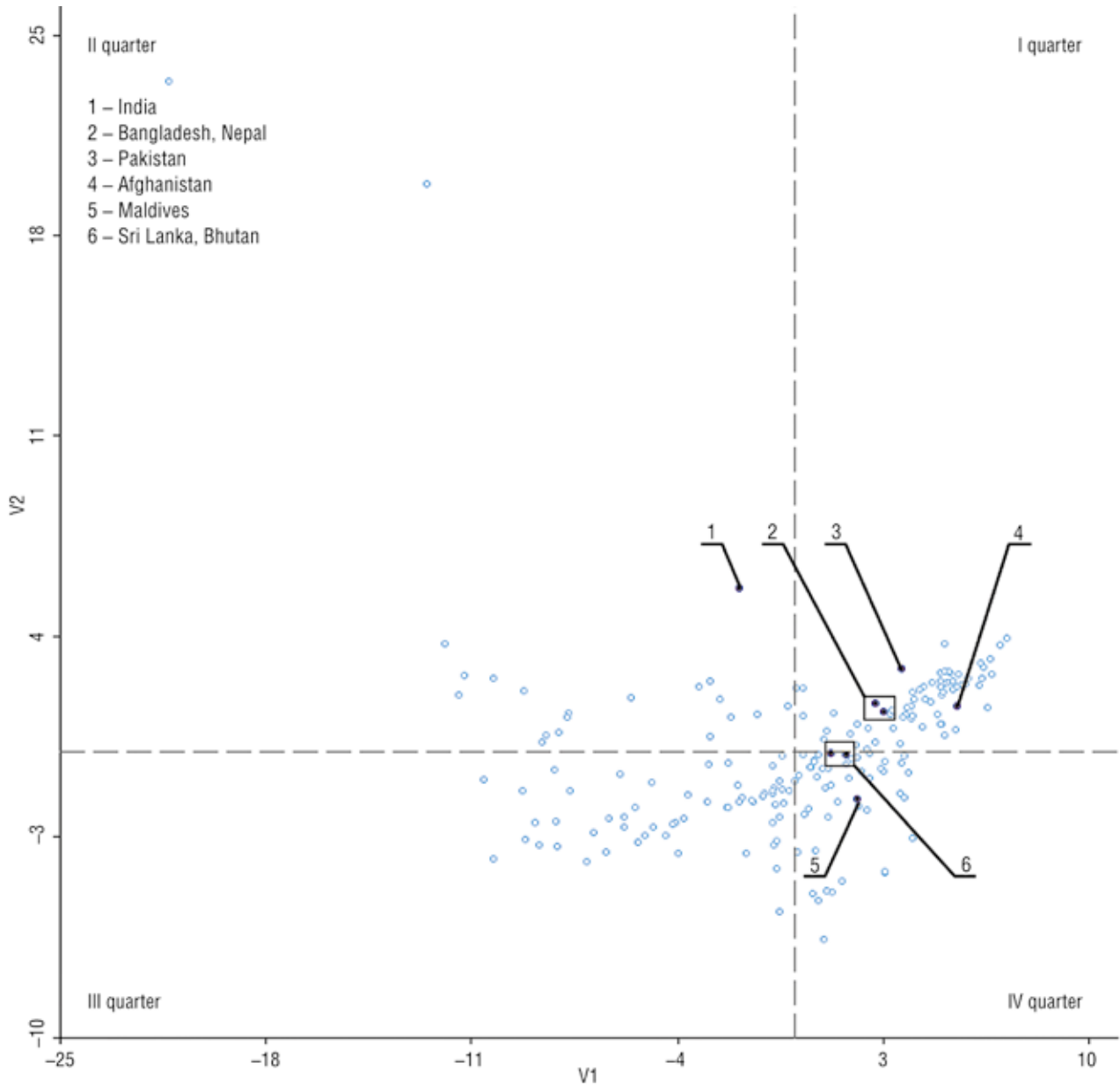


Fig. 13.11. SAARC

The weakest correlation between the location of countries on the scatter plot and belonging to a bloc (and, as a result, where clustering is absent) is observed in the countries of the ASEAN+3 (Fig. 13.15). This dispersion is a result of the high level of economic and political differentiation, as well as the cultural differences between the states of the region. Not a single country can come close to China on the chart, and the remaining countries are closer to each other geographically. Only one group stands out on the graph — specifically the one that is made up of the region's least developed countries (Myanmar, East Timor and Laos), which are located in Quadrant I. It is also worth noting that the city-state of Singapore is, in terms of aggregate indicators, more similar to the larger developed states of the West than to its geographical neighbours or to other small states.

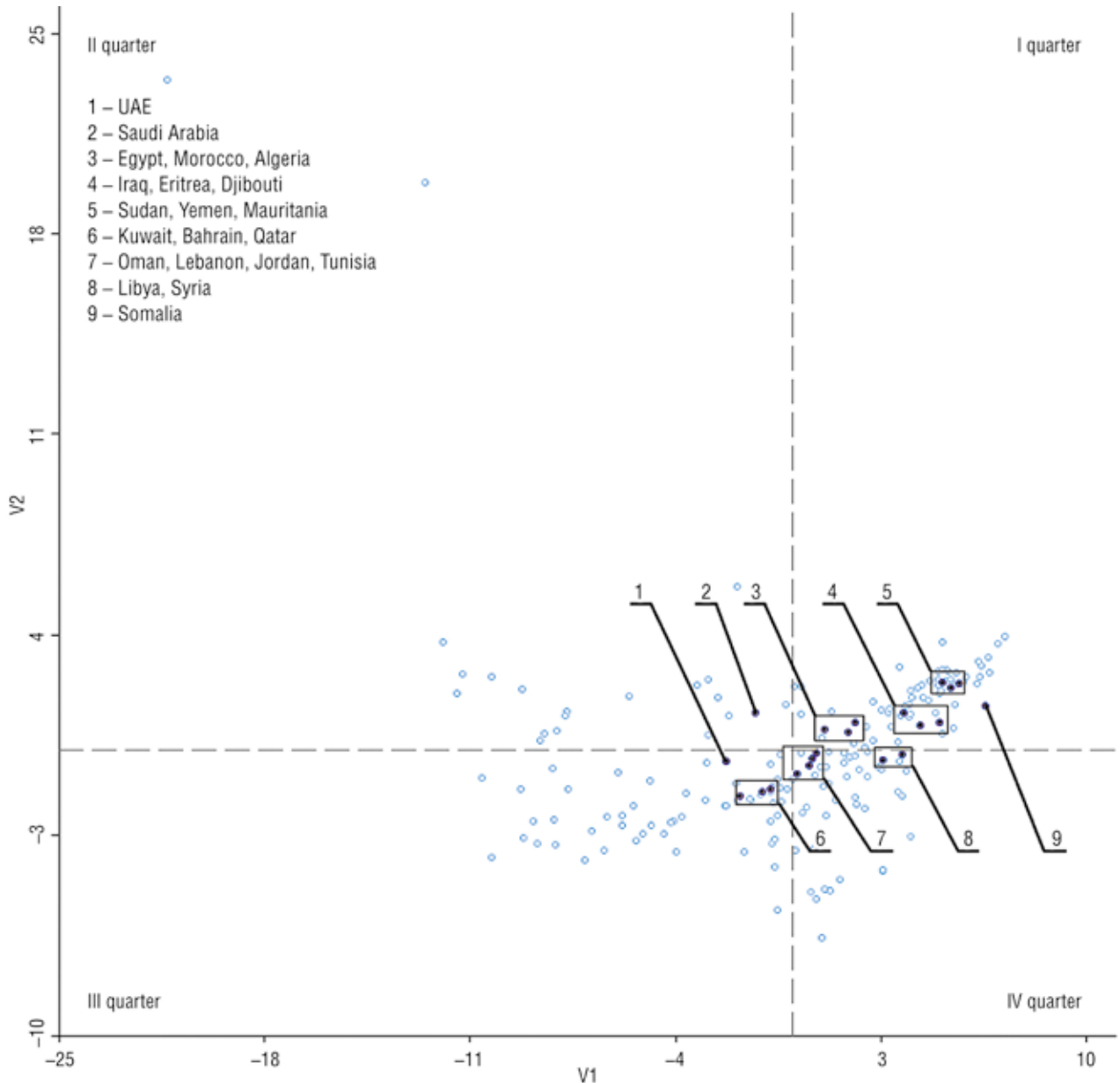


Fig. 13.12. GCC-LAS

Four countries that are not part of any regional bloc — Israel, Mongolia, North Korea and Iran — do not form a cluster in the multidimensional scaling diagram. Nor are they located separately from other states (Fig. 13.16). In terms of socioeconomic development, Israel is closer to developed democracies than to the countries of its region, a natural consequence of its close economic and political ties with Western countries and the lack of diplomatic recognition from certain Arab countries. Iran, one of the countries that does not recognize Israel, is among the most developed economies in the Islamic world and is thus located on the border between quadrants I and II on the chart. The country that is closest to Iran in terms of its cumulative scores for the 100 indicators we have looked at is Vietnam.

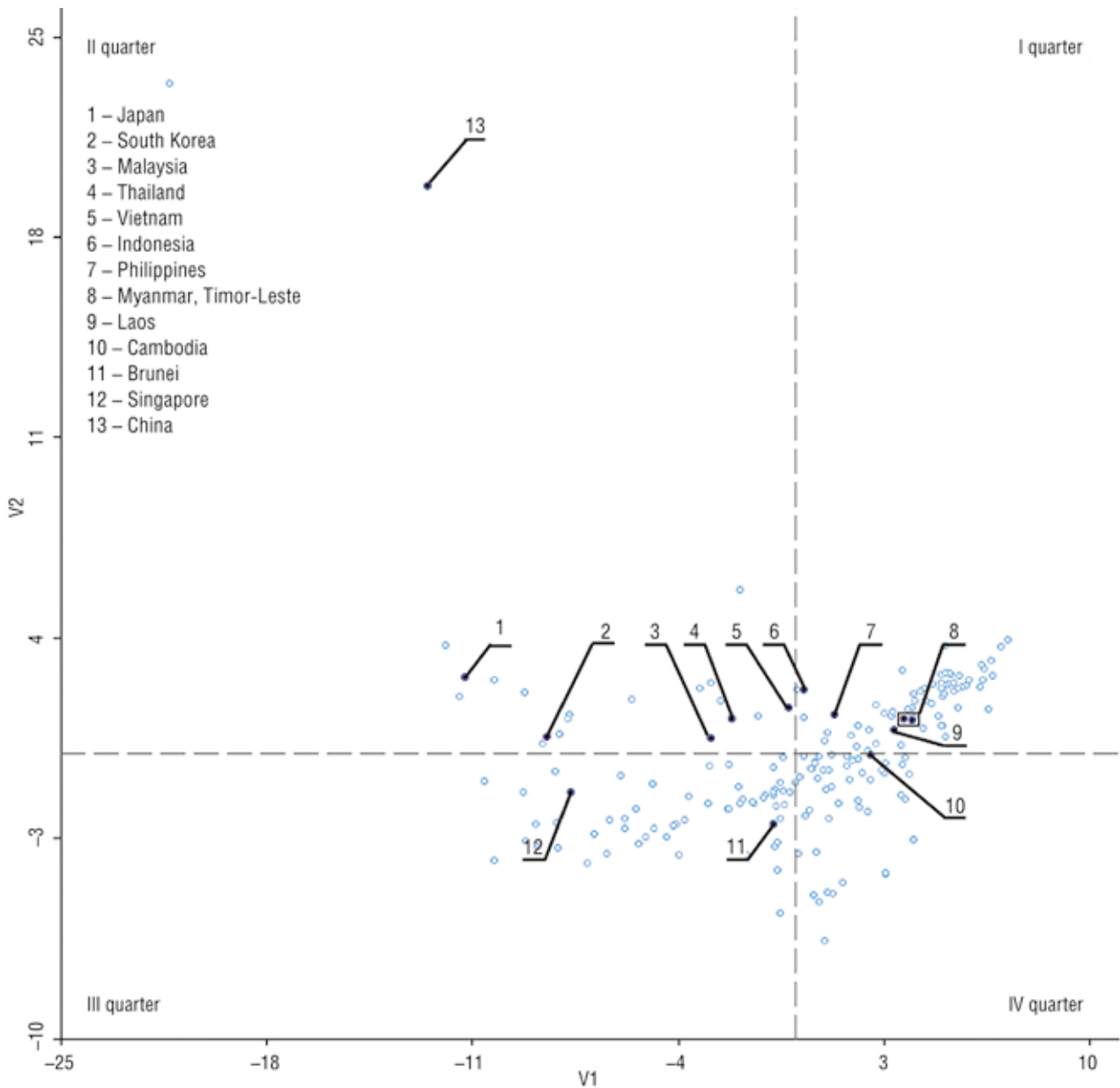


Fig. 13.13. ANZUS-CU

The isolate countries in Asia — Mongolia and North Korea — are located in Quadrant IV of the diagram. Mongolia, which geographically is located between China and Russia and maintains close economic and political ties with them, is most similar to Oman and Ecuador in terms of its development. North Korea is also characterized by a significant economic lag behind other countries of the region. However, in this case, its location on the chart is primarily influenced by its closedness and the fact that data simply does not exist for almost half of the indicators we analysed.

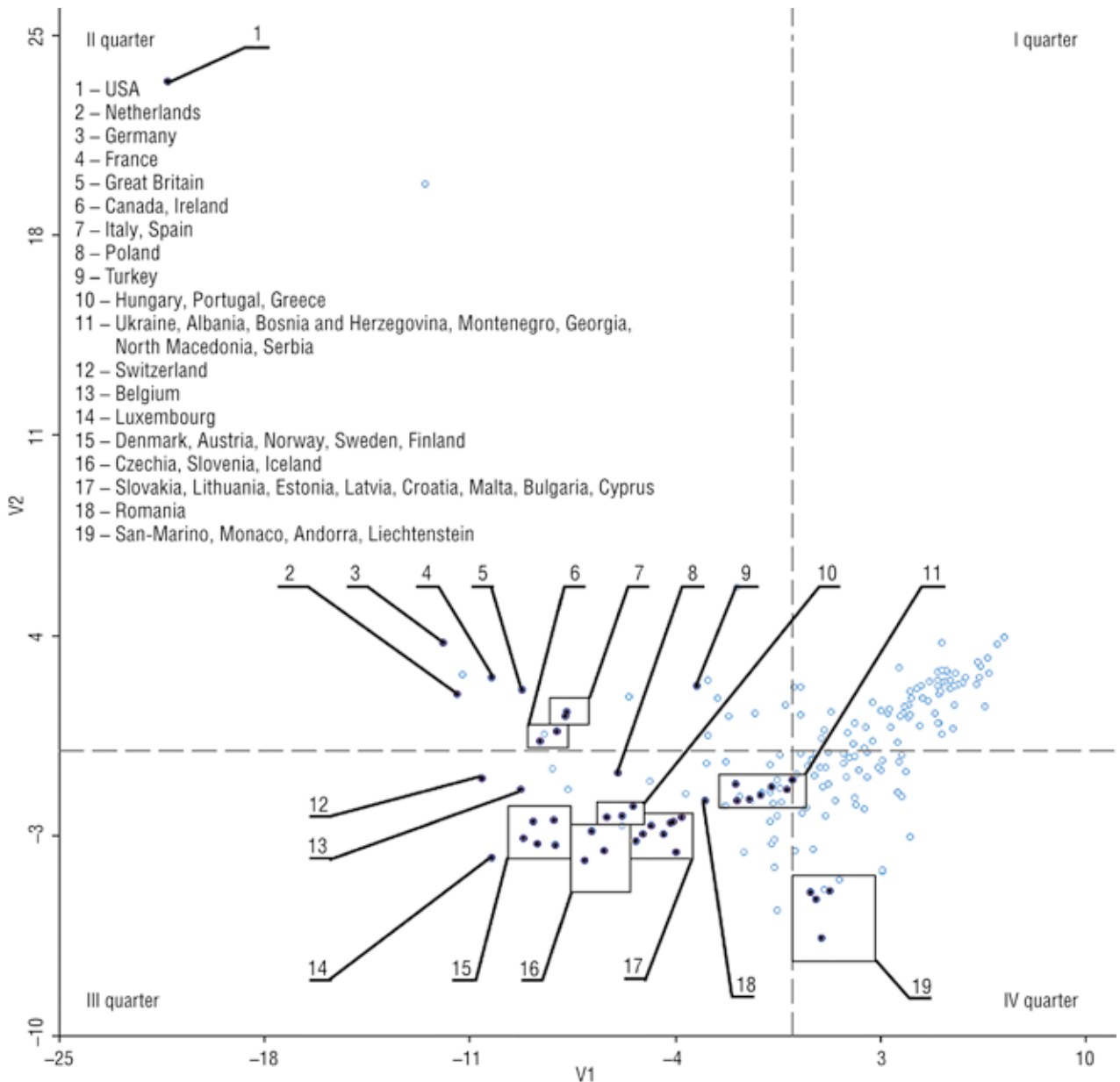


Fig. 13.14. NATO–EU–EFTA–EUCU–SAA/AA

Multidimensional scaling diagrams are useful for showing, if not the position of each country in the modern world order, then the dynamics of development of states relative to each other. This methodology allows us, among other things, to compare the totality of the indicators we have considered in this study to further assess the similarity and difference of states within the framework of political and economic regional integration associations. In particular, integration groupings of the most similar states (for example, UEMOA–ECOWAS) may in practice turn out to be less effective than unions of countries that are most different from each other (as in the case of ASEAN+3). A qualitative analysis of the diagrams leads us to the conclusion that there is no direct relationship between the similarity of states and the success of integration systems, and that similarity is thus not a prerequisite for successful integration.

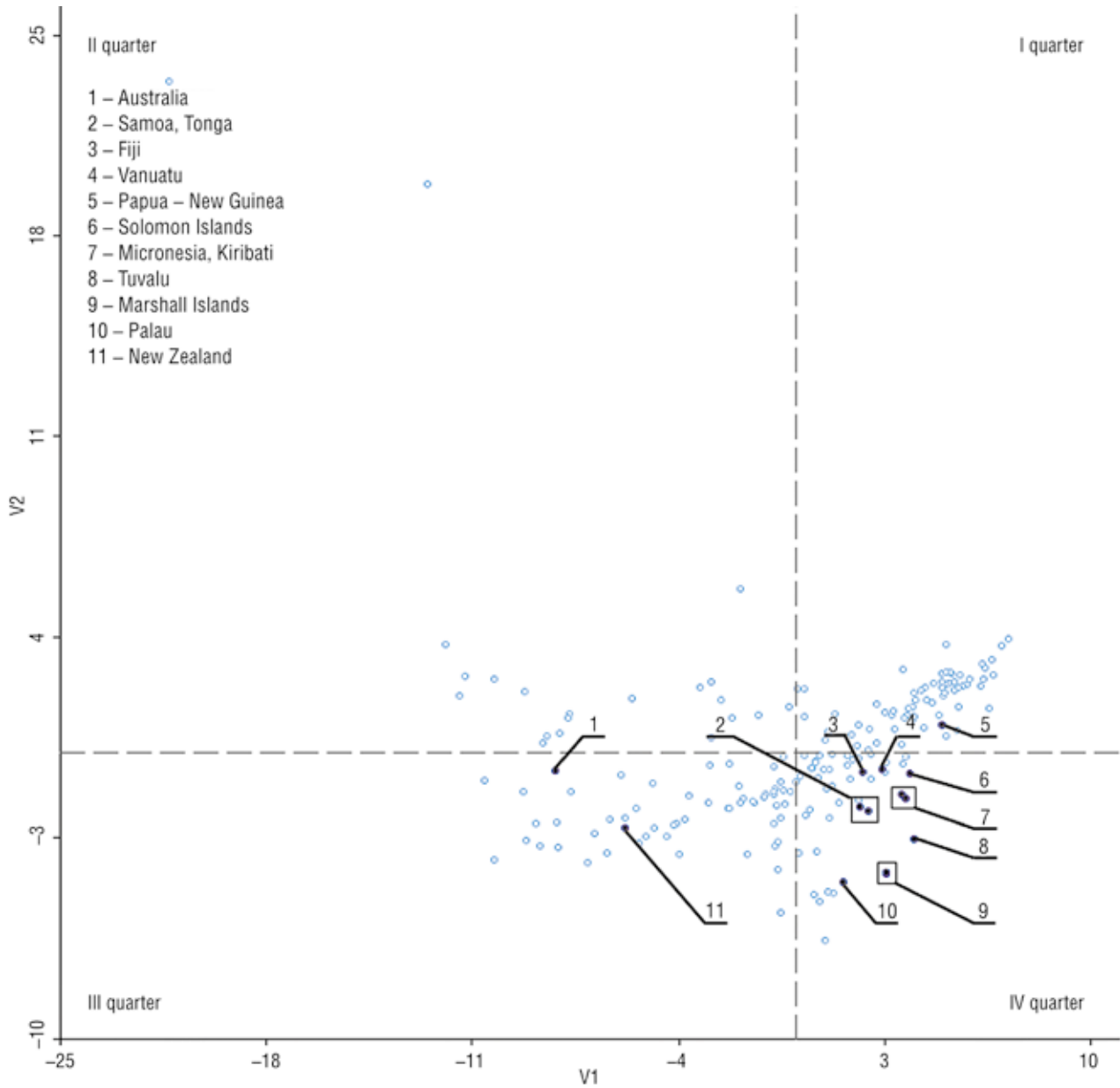


Fig. 13.15. ASEAN+3

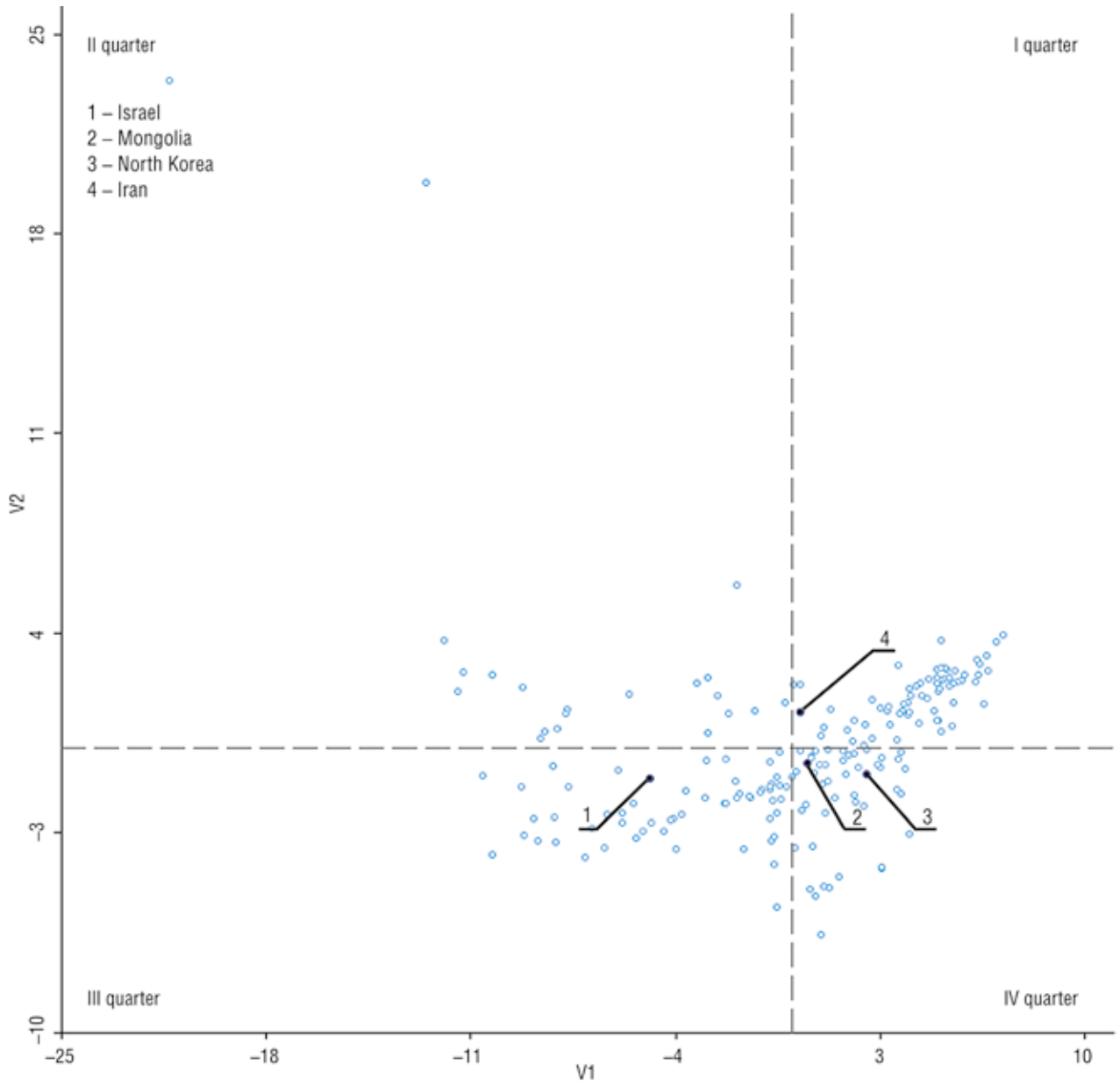


Fig. 13.16. Isolate countries

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